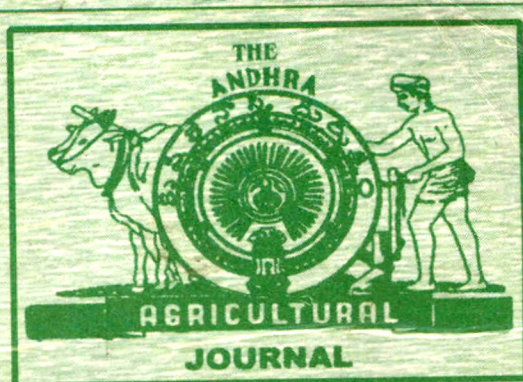


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one that warms your heart
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3

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Performance of Herbicides for Weed Control in Transplanted Rice (*Oryza sativa* L.)

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ABSTRACT

An investigation carried out at Agricultural Research Institute, Rajendranagar, Hyderabad for weed control in rice crop during *kharif*, 2000 revealed that application of Anilofos + Ethoxysulfuron (Rice guard) @ 0.375 + 0.012 kg a.i. ha⁻¹ and Butachlor (Machete) @ 1.5 kg a.i. ha⁻¹ were more effective in controlling the weeds and reducing crop weed competition by recording higher yield components thus producing higher grain and straw yields of rice which were comparable to hand weeding twice at 20 and 40 DAT and significantly superior over rest of the herbicidal treatments.

key words : Herbicides, Weed Control and Transplanted Rice

Rice is the main *kharif* crop grown commonly by farmers under transplanted conditions. Weed flora in rice is dynamic and varies with location and growing conditions. Weeds effectively compete with the transplanted rice and reduce the crop yield to an extent of 40-55 per cent (Saikia and Purushothamam, 1996). The competition is severe during early stages of crop requiring a weed free situation of 40 DAT (Savithri *et al.*, 1994). Chemical weed control of weeds is gaining ground because of high cost of labour, lack of timely availability of labourers during peak periods due to their migration to urban industrial areas and continuous rains during wet season; which do not allow timely control of weeds by manual method. In recent years combination of herbicides has been found effective in controlling wide range of weed species in rice (Rao and Singh, 1994). The present investigation was undertaken to evaluate the performance of different herbicides for controlling weeds in transplanted rice.

MATERIAL AND METHODS

An investigation was undertaken at Rice Section, Agricultural Research Institute,

Rajendranagar, Hyderabad during *Kharif* 2000. The experimental site was clayey loam with pH 8.2, medium in organic matter content (0.54%), low in available nitrogen (279 kg ha⁻¹), medium in available phosphorus (30.6 kg ha⁻¹) and available potassium (235 kg ha⁻¹). Sixteen treatments viz., Butachlor (Machete) @ 1.5 kg a.i. ha⁻¹, Cinmethylin+2, 4-DEE (Argold) @ 0.375 kg a.i. ha⁻¹, 0.50 kg a.i. ha⁻¹, Flufenacet (Drado) @ 0.09 kg a.i. ha⁻¹, 0.12 kg a.i. ha⁻¹, Anilofos+Ethoxysulfuron (Rice guard) @ 0.312 + 0.012 kg a.i. ha⁻¹, Acetochlor @ 0.10 kg a.i. ha⁻¹, 0.150 kg a.i. ha⁻¹, Pyrazosulfuron-ethyl @ 0.010 kg a.i. ha⁻¹, 0.015 kg a.i. ha⁻¹, Alkombo @ 0.204 kg a.i. ha⁻¹, Almix+Butachlor @ 0.004 + 1.0 kg a.i. ha⁻¹, Butachlor fb Almix @ 1.0 fb 0.004 kg a.i. ha⁻¹ were applied (Table 1), two hand weedings at 20 and 40 DAT, weedy check and weed free checks were arranged in randomized block design with three replications. Weed free check was maintained by six hand weedings upto 90 DAT. All the herbicides were sprayed as per treatments by mixing in water @ 500 L ha⁻¹ using sprayer with flat pan nozzle. Seedlings of rice cv. Satya (RNR-1446) were transplanted on 1st August 2000 at a spacing of 20 x 10 cm and

Table 1 : Weed growth and crop growth as effected by weed control treatments (30 DAT)

Treatments	Concentration (%)	Dose (kg a.i. ha ⁻¹)	Time of application (DAT)	Weed population (No.m ⁻²)	Weed dry weight(gm ⁻²)	Weed control efficiency(%)	Crop height (cm)	Crop dry weight (g m ⁻²)
Butachlor	50 EC	1.50	3-7	33.6 (5.83)	21.1	72.4	24.4	81.6
Cinmethylin+2,4-DEE	50 EC	0.375	7	44.6 (6.71)	11.0	85.6	23.6	74.5
Cinmethylin+2,4-DEE	50 EC	0.500	7	36.0 (6.04)	10.7	86.0	23.1	80.7
Flufenacet	60 WP	0.09	3-5	51.8 (7.23)	14.9	80.5	23.6	76.7
Flufenacet	60 WP	0.12	3-5	43.9 (6.66)	10.9	85.7	23.2	81.5
Anilofos+Ethoxysulfuron	25 + 1 WP	0.312+0.012	10	30.0 (5.52)	8.9	88.3	25.2	88.4
Acetochlor	90 EC	0.100	3-7	45.4 (6.77)	22.8	70.2	22.3	74.5
Acetochlor	90 EC	0.150	3-7	38.6 (6.25)	13.4	82.5	23.5	78.5
Pyrazosulfuron-ethyl	10 WP	0.010	8	40.6 (6.41)	40.3	47.5	23.2	76.6
Pyrazosulfuron-ethyl	10 WP	0.015	8	36.2 (6.05)	29.4	61.6	24.7	80.8
Alkombo	25.5 WP	0.204	3	34.1 (5.88)	32.3	57.8	23.5	80.5
Almix+butachlor	20 WP+50 EC	0.004+1.0	3	30.1 (5.53)	17.9	76.6	24.3	82.0
Butachlor fb Almix	50 EC fb 20 WP	1.0 fb 0.004	3 fb 21-25	32.8 (5.77)	19.6	74.4	25.0	86.0
Hand weeding	-	-	20&40	12.0 (3.53)	8.0	89.5	26.6	92.5
Unweeded check	-	-	-	99.2 (9.98)	76.7	-	21.1	50.5
Weed free check	-	-	-	4.2 (2.16)	2.3	97.0	29.4	125.9
S.E.m _t	-	-	-	0.66	2.1	-	0.8	1.9
CD (P=0.05)	-	-	-	1.99	6.2	-	2.3	5.5

Note : Figures in parenthesis indicate $\sqrt{x+0.5}$ transformed values

a uniform fertilizer dose of 120 kg N (urea), 60 kg P₂O₅ (SSP), 40 kg K₂O (MOP) and 50 kg ZnSO₄ was applied. Entire dose of P₂O₅, ZnSO₄ along with 1/3rd N and 3/4th K₂O was applied basally while rest of the nitrogen was applied in two equal splits at maximum tillering, panicle initiation and K₂O at panicle initiation alone. Weeds were removed with 0.5 x 0.5 m quadrat at 30 DAT and converted to 1m² area. Weeds were first sun dried followed by oven drying to a constant temperature at 80°C. The resultant dry matter is expressed in gm⁻². Crop samples were collected (5 hills) at 30 DAT for dry matter computation. Irrigation water was maintained upto 2 cm until establishment of seedlings and later upto 5 ± 2 cm until physiological maturity (irrigation once in 2 days), later drained off before harvest of the crop.

RESULTS AND DISCUSSION

The dominant weed flora recorded in the experimental field consisted of *Echinochloa colona* (L), *Panicum repens* (L), *Paspalum distichum* (L), *Cynodon dactylon* (L), among grasses, *Cyperus difformis* (L), *Cyperus iria* (L), *Scirpus supinus* (L), *Fimbristylis dichotoma* (L), among sedges and *Caesulia axillaris* (Roxb), *Eclipta alba*, *Ammania baccifera* (Koehme) and *Marselia minuta* among broad leaved weeds.

Weed density and weed dry weight at 30 DAT were significantly effected by different weed control treatments (Table 1). Among the different treatments next to weed free check, hand weeding twice at 20 and 40 DAT has recorded significantly lower weed density and dry matter. Among the herbicides rice guard recorded significantly lower

Table 2 : Yield componets and yield as effected by weed control treatments

Treatments	Concentration (%) (DAT)	Dose (kg a.i. ha ⁻¹)	Time of application	Effective population	Filled grains weight (g m ⁻²)	Panicle efficiency (%)	Panicle height	1000 Grain Weight (g)	Grain	Straw
Butachlor	50 EC	1.50	3-7	463	131	20.0	2.24	21.3	4.73	5.85
Cinmethylin+2,4-DEE	50 EC	0.375	7	426	89	20.7	1.99	20.7	3.84	5.20
Cinmethylin+2,4-DEE	50 EC	0.500	7	432	97	20.1	2.00	19.9	3.70	5.02
Flufenacet	60 WP	0.09	3-5	428	90	19.7	2.12	19.6	4.14	5.61
Flufenacet	60 WP	0.12	3-5	442	90	20.7	2.10	20.9	4.46	5.65
Anilofos+Ethoxysulfuron	25 + 1 WP	0.312+0.012	10	485	143	20.2	2.25	21.4	4.81	5.90
Acetochlor	90 EC	0.100	3-7	135	98	19.6	2.11	19.3	4.18	5.55
Acetochlor	90 EC	0.150	3-7	442	111	20.2	2.07	20.4	4.48	5.80
Pyrazosulfuron-ethyl	10 WP	0.010	8	435	109	19.5	2.02	20.1	4.31	5.49
Pyrazosulfuron-ethyl	10 WP	0.015	8	450	124	20.4	1.99	18.8	4.53	5.24
Alkombo	25.5 WP	0.204	3	446	124	20.4	2.01	20.5	4.41	5.70
Almix+butachlor	20 WP+50 EC	0.004+1.0	3	472	128	20.4	2.20	20.2	4.60	5.51
Butachlor fb Almix	50 EC fb 20 WP	1.0 fb 0.004	3 fb 21-25	469	130	20.8	2.19	20.5	4.61	5.33
Hand weeding	-	-	20&40	490	157	20.3	2.35	21.5	4.87	5.95
Unweeded check	-	-	-	325	81	19.3	1.81	18.0	3.04	4.20
Weed free check	-	-	-	510	171	21.3	2.44	21.6	5.18	6.20
S.E.m _±	-	-	-	8	5	0.3	0.06	0.2	0.06	0.03
CD (P=0.05)	-	-	-	24	15	1.1	0.18	0.5	0.20	0.09

weed density and lower weed dry matter which was comparable with hand weeding at 20 and 40 DAT which was due to the ability of this herbicides mixture in controlling wide range of weed species ranging from grasses, sedges to broad leaved weeds (Sandeep *et al.*, 2002). Further the weed control efficiency of the herbicide was higher than all other herbicides and nearly equal to two hand weedings.

The highest weed density and weed dry matter were recorded in unweeded check due to luxuriant growth of weeds at the expense of crop.

The yield attributes and yield were significantly effected by different weed control methods.

Application of Rice guard was equally effective as two hand weedings at 20 and 40 DAT in controlling weeds and recorded higher yield attributes like plant height, dry matter, effective tillers, filled grains per panicle, panicle length, weight and 1000 grain weight followed by application of Butachlor @ 1.5 kg a.i.ha⁻¹.

Higher yield attributes in the above herbicide treated plots had resulted in higher grain and straw yields which were comparable with two hand weedings at 20 and 40 DAT, while the lowest grain yield of 3.04 t ha⁻¹ was recorded in unweeded check due to severe crop weed competition.

The trial revealed that uncontrolled weeds in transplanted rice could reduce the grain yield

to an extent of 35.5 per cent and the highest yield of 5.18 t ha⁻¹ was recorded in weed free check.

The above results revealed that in *kharif* transplanted rice, application of Anilophos + Ethoxysulfuron @ 0.375 + 0.012 kg a.i. ha⁻¹ or Butachlor @ 1.5 kg.a.i.ha⁻¹ were equally effective as two hand weeding at 20 and 40 DAT.

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Influence of Sowing Methods and Fertilizer Management on The Growth and Yield of Groundnut in South Saurashtra Region of Gujarat

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ABSTRACT

In a field experiment laid out at the instructional farm, Gujarat Agricultural University, Junagadh campus, groundnut variety GG-20 was tested in four methods of sowing and three levels of fertilization. Sowing in ridges and furrows, broad bed and furrows and after deep ploughing registered significantly higher growth parameters and yield of groundnut over the flat bed method of sowing. Application of 100 per cent recommended dose of fertilizers was significantly superior to 50% recommended dose of fertilizer + 5 tonnes of FYM ha⁻¹ and control treatments and recorded the highest growth characters and yield.

Key words : Fertilization, Groundnut, Methods of sowing

Oilseed crops are considered as the backbone of Agricultural economy in India. Among the oilseed crops grown in India, groundnut contributes 29.13% of the total area and 36.13% of the total production. Groundnut crop ranks first in area and second in production in the world. (DOES, 1998). However, the productivity of groundnut in India is less than half of the major groundnut growing countries.

Among the several factors responsible for low groundnut yields under rainfed conditions, rainwater conservation and fertilizer application are most important. Hence increase in the groundnut yield by adopting suitable seed bed that effectively conserves rain water besides applying requisite fertilizers assume significance. Several researchers reported increased groundnut yield due to *insitu* moisture conservation (Basu, 1999). Pod and haulm yield increase due to fertilizer application under rainfed conditions was also reported by Malavia *et al.*, (1999).

MATERIAL AND METHODS

A field experiment was conducted for two consecutive years during *Kharif* at the Instructional farm, Gujarat Agricultural University, Junagadh campus. The experimental soil was clayey having 264, 31 and 171 kg ha⁻¹ available nitrogen, P₂O₅ and K₂O respectively with a pH of 7.8. The treatments consisted of four methods of sowing *viz.*, sowing in flat bed, ridges and furrows, broad bed and furrows and deep ploughing (25-30 cm depth) as main plots and three fertilizer management treatments as sub plots i.e., control, 50% recommended dose of fertilizers + 5t FYM ha⁻¹ and 100% recommended dose of fertilizers laid out in split plot design replicated thrice. Groundnut variety very popular among farmers, G G-20 was sown in the second week of June and harvested in the second week of October during both the years of experimentation. The crop was raised following all the recommended package of practices. Observations on growth and yield of groundnut

Table 1 : Effect of sowing methods and Fertilizer Management on Growth Parameters of Groundnut

Treatments	Plant height at harvest (cm)	Plant spread at harvest (cm)	Dry matter accumulation plant at harvest (g)	Average number of-- at 60 DAS	Leaf area index at 60 DAS
Sowing Methods					
Flat bed	24.8	53.7	19.6	90.6	3.8
Ridges and Furrows	28.3	58.6	21.7	118.8	3.8
Broad bed and Furrows	29.6	58.9	22.3	120.3	3.9
Deep ploughing during land preparation	28.7	60.0	22.2	122.7	3.9
S E m ±	0.7	1.1	0.4	3.8	0.1
C D (0.05)	2.2	3.3	1.0	11.3	N S
Fertilization treatments					
Control	24.8	54.3	19.0	101.3	3.4
50% RDF + 5t ha ⁻¹ FYM	28.1	57.9	21.9	120.2	3.9
100% R D F	30.8	60.9	23.4	117.9	4.2
.SEm±	0.6	0.7	0.2	7.2	0.05
C D (0.05)	1.6	2.0	0.6	12.6	0.14

DAS - Days after sowing

RDF -Recommended dose of fertilizers (12.5 kg N and 25 kg P₂O₅ ha⁻¹)

crop were taken and analysed by adopting standard procedures to draw conclusions.

RESULTS AND DISCUSSION

Growth Characters

Effect of Sowing methods.

Pooled data on growth and yield of groundnut crop are presented in Tables 1 and 2. Growth parameters except the leaf area index of groundnut crop were significantly influenced by sowing methods. Sowing on ridges and furrows, broad bed and furrows and bed deeply ploughed recorded significantly higher plant height, plant spread, dry matter accumulation, number of nodules over flat bed method, however these three treatments were statistically comparable to one another. The lowest values of the growth characters were registered under flat beds. Better performance of the crop due to altered land configurations might be attributed to favourable, loose and supporting soil at the base, facilitating

aerated situation for better rainwater conservation and higher availability of soil moisture for longer periods. Similar results were also reported by Desai (1989) and Munuswamy *et al.*, (1998).

Effect of Fertilizer Treatments

Fertilization treatments differed significantly among all the growth parameters, studied. Application of 100% RDF registered the maximum plant height (30.8 cm), plant spread (60.9 cm) dry matter accumulation plant⁻¹ (923.4g) and leaf area index (4.2), which was followed by 50% RDF + 5t FYM ha⁻¹. Control treatment registered significantly the lowest values with regard to the growth characters. Growth and development of plant depends upon differentiation and expansion of component cells. Nitrogen and phosphorus encourage the formation of new cells, cell division and cell multiplication. Thus, the increased growth parameters, could be due to the improved

Table 2 : Effect Of Sowing Methods and Fertilizer Management On Yield Of Groundnut Crop.

Treatments	Pod yield (q ha ⁻¹)	Haulm yield (q ha ⁻¹)	Harvest Index (%)	Oil Yield (kg ha ⁻¹)	Protein yield (kg ha ⁻¹)
Sowing Methods					
Flat bed	19.0	28.7	39.8	670	286
Ridges and Furrows	22.8	33.2	40.1	819	352
Broad bed and Furrows	23.9	35.2	40.3	866	373
Deep ploughing during land preparation	23.8	35.2	40.3	864	370
S E m ±	0.7	1.1	1.09	30.9	10.8
C D (0.05)	2.2	3.3	NS	91.9	32.2
Fertilization treatments					
Control	19.5	30.4	39.2	687	292
50% RDF + FYM 5 t ha ⁻¹	22.5	33.3	40.1	819	347
100% R D F	25.2	35.6	41.5	919	398
.SEm±	0.6	0.8	0.74	21.8	9.2
C D (0.05)	1.7	2.3	NS	62.0	26.2

nutritional environment. Similar results were also reported by Asodariya (1994).

Yield Effect of Sowing Methods

Pooled data on groundnut yield presented in Table 2 indicated the significant impact of the treatments tried.

Sowing under ridges and furrows, broad bed and furrows and in beds deep ploughed were statistically comparable in terms of pod and haulm yields as well as oil and protein yields, which were significantly superior to sowing in flat beds. The highest yield was registered by sowing in altered land configurations, where as the least pod (19.0 q ha⁻¹), haulm (28.7 q ha⁻¹), oil (670 kg ha⁻¹) and protein (286 kg ha⁻¹) yields were recorded by sowing groundnut in flat beds. In flat beds, the soil moisture was lower. The lower available soil water might have increased the soil temperature as compared to other methods of sowing, where soil moisture availability was not a constraint. Thus, the higher soil temperature along with low available soil moisture might have resulted in closure of stomata, which tend to raise plant's temperature. This would have lead

to greater breakdown of the assimilates. This phenomenon has a special significance in groundnut being a C₃ Plant, where high temperature is conducive for photorespiration and results in lower pod and haulm yields. Lower pod yield might have resulted in lower oil and protein yields in flat bed method of sowing. Similar results were reported by Patra *et al* (1994) and Basu (1999).

Effect of Fertilizer Treatments

Fertilizer treatments differed significantly with regard to groundnut yield. The highest pod (25.2 q ha⁻¹), haulm (35.6 q ha⁻¹), oil (919 kg ha⁻¹) and protein (398 kg ha⁻¹) yields were registered by the application of 100% RDF, followed by application of 50% RDF + 5t FYM ha⁻¹. The lowest yield was recorded in control treatment. Groundnut yield is an output of sequential metamorphosis of photosynthates from source to sink. Higher growth and partitioning of photosynthates from vegetative source to sink might have resulted in higher yields in the fertilized treatments over control. Similar results were also reported by Parasuraman *et al* (1998).

To achieve higher growth and yield of groundnut, sowing in ridges and furrows, broad bed and furrows or in plots ploughed deep besides applying 100% recommended fertilizers were found to be the best in South Saurashtra region of Gujarat.

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Influence of Bacterial Inoculation and Foliar Nutrition of Phosphorus on Yield Attributes, Yield and P Uptake of Irrigated Groundnut

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ABSTRACT

A field trial was conducted at the Agricultural College Farm, Bapatla to study the possibility of reducing phosphorus application through combined inoculation of *Rhizobium* and Phosphobacterium in groundnut (TMV 2). Maximum crop growth, nodulation, yield and P uptake were obtained in a treatment that received combined inoculation of *Rhizobium* and PSB, 25% recommended phosphorus through MAP as foliar spray at 30 and 60 DAS with 75% of P as basal application. Since there is no significant difference between the treatments that received 75% and 100% recommended phosphorus along with combined inoculation, results in saving of 25% of phosphorus fertilizer.

Key words : *Rhizobium*, Phosphobacteria, Combined inoculation and Foliar nutrition.

Biofertilizers have been recognised as a vital component in the integrated nutrient supply system. They are ecofriendly, low cost agricultural inputs playing a significant role in improving the nutrient availability to crops. Performance of biofertilizers is some times inconsistent due to their biological nature and susceptibility to biotic and abiotic stresses. Appropriate combination of bioinoculants and fertilizers besides organic matter would meet the crop nutrient requirements on a sustainable basis.

Groundnut mostly grown in rainy season (*kharif*), however, of late it is also raised in winter (*rabi*) and summer seasons, depending on the temperature regime. Intensive crop cultivation demands the use of chemical fertilizers, which are not only in short supply but also very expensive. Therefore, the current trend is to explore the possibility of supplementing these chemical fertilizers with biofertilizers, which hold the key to the solution of current problem of

fertilizer scarcity and expensiveness. Besides nitrogen, phosphorus is the second most important nutrient in crop production. The efficacy of utilization of added P by plants is very low (15-25%) due to fixation. The phosphobacteria solubilize phosphorus and make it available to the plants. Hence, the present investigation was taken up to know the possibility of reducing the application of fertilizer phosphorus with combined inoculation of *Rhizobium* and phosphobacteria.

MATERIAL AND METHODS

A field investigation was carried out in *rabi*, 2001 at the Agricultural College Farm, Bapatla, to find out the possibility of reducing 'P' fertilizer by combining two biofertilizers. The mean minimum and maximum temperatures during the crop growth period ranged from 16.2°C to 22.5°C and 27.8°C to 32.2°C respectively. A total rainfall of 12.9 mm was recorded during the period of study. The experimental soil was sandy loam

Table 1 : Effect of biofertilizers along with foliar nutrition of P on growth, yield attributes, yield and P uptake of ground nut

Treatments	Number of nodules plant ⁻¹ at 60 DAS	Nodule dry weight plant ⁻¹ (mg)	Filled pods plant ⁻¹	100-kernel weight (g)	Pod yield (kg ha ⁻¹)	P uptake at harvest (kg ha ⁻¹)
P ₀	50.3	42.2	13.9	27.3	1408	8.7
FP ₁₀₀	89.7	92.5	18.9	32.3	1802	14.7
FP ₁₀₀ + PSB	98.8	106.6	19.3	32.6	1876	16.6
FP ₇₅ + PSB	94.2	104.3	18.3	31.8	1710	14.4
FP ₇₅ + MAP ₂₅ (30 DAS)	96.3	107.2	20.0	32.9	1965	17.5
FP ₇₅ + MAP ₂₅ (30 & 60 DAS)	98.7	108.4	20.2	33.1	2005	18.1
FP ₇₅ + MAP ₂₅ PSB (30 DAS)	108.7	121.5	22.8	36.9	2243	19.8
FP ₇₅ + MAP ₂₅ PSB (30 & 60 DAS)	40.0	123.0	23.9	37.2	2276	20.3
SEm _±	2.8	3.4	0.4	1.2	77.8	0.3
CD (P = 0.05)	8.5	10.3	1.3	3.6	235	0.9

and well drained having pH 7.8, organic carbon 0.35 per cent, low in available N (225 kg ha⁻¹) and high in potassium content (486 kg ha⁻¹).

The experiment comprised eight treatment combinations laid in randomized block design was replicated thrice. The inoculation of *Rhizobium* was common and phosphobacteria as per treatment schedule. The variety used was TMV-2 and the seeds were sown after inoculation. For combined inoculation, equal quantity of peat based inoculation of *Rhizobium* and phosphobacterium were used. Recommended irrigation schedules, nitrogen and potassium doses were given. Foliar application of phosphorus through Monoammonium phosphate (MAP-12-61-0 (NPK)) @ 0.5% concentration with power sprayer was given. The treatment details are as follows.

- T₁ - No phosphorus (P₀)
 T₂ - 100% phosphorus as basal (FP₁₀₀)
 T₃ - 100% phosphorus as basal and seed inoculation with phosphorus solubilizing bacteria (FP₁₀₀+PSB)
 T₄ - 75% Phosphorus as basal and seed inoculation with phosphorus

- solubilizing bacteria (FP₇₅+PSB)
 T₅ - 75% phosphorus as basal and 25% phosphorus through mono-ammonium phosphate as foliar spray at 30 days after sowing FP₇₅ MAP₂₅ (30 days)
 T₆ - 75% phosphorus as basal and 25% phosphorus through mono ammonium phosphate as foliar spray at 30 and 60 days after sowing FP₇₅+MAP₂₅ (30 and 60 DAS)
 T₇ - 75% phosphorus as basal and 25% phosphorus through mono ammonium phosphate as foliar spray at 30 days after sowing and seed inoculation with phosphorus solubilizing bacteria FP₇₅+MAP₂₅ (30 DAS) + PSB
 T₈ - 75% phosphorus as basal and 25% phosphorus through monoammonium phosphate

as foliar spray at 30 and 60 days after sowing and seed inoculation with phosphorus

solubilizing bacteria $FP_{75} + MAP_{25}$
(30 and
60 DAS
+ PSB

RESULTS AND DISCUSSION

The highest nodule number, nodule dry weight, filled pods plant⁻¹, yield and P uptake was obtained in treatment that received combined inoculation of *Rhizobium* and phosphobacteria, 25% recommended Phosphorus through MAP as foliar spray at 30 and 60 DAS and 75% P as basal application. The crop response to combined inoculation of *Rhizobium* and phosphobacteria at 75% and 100% P levels was on a par with each other (Table 1). This indicates that a saving of 25% inorganic phosphate fertilizer on combined inoculation of *Rhizobium* and phosphobacteria.

The increase in crop growth due to combined inoculation in the present study might be due to growth regulators produced by *Rhizobium* and *Bacillus* and also might be due to the solubilization of insoluble phosphates by production of various organic acids by *B. megaterium* (Sperber, 1958). It has also been reported that plant hormones might play a role in the infection mechanism of *Rhizobium* (Nutman, 1965; Shena Khanova, 1979). Hence, the enhanced nodulation of groundnut also been attributed to the growth regulating substances produced by *Bacillus* sp. Similar enhancement in the dry matter production by combined inoculation of phosphate solubilising and nitrogen fixing micro organisms was also reported by

Kalugasalam (1981). Foliar application at 30 and 60 DAS results in continuous and adequate supply of P through out the growth period. When there is no short supply of phosphorus the plant could accumulate the required quantity of phosphorus through the combination of sources, which in turn helped in the better performance of the yield attributing characters and pod yield. Enhanced uptake of P by the groundnut crop can be attributed to the increased total nutrient content due to the increased nodulation that enabled the plant to extract more nutrients and accompanying increase in pod yield.

The present study indicated that the combined inoculation of *Rhizobium* and phosphobacteria resulted in saving of 25% of P fertilizer and the crop performed better with MAP foliar spray at 30 and 60 DAS along with combined inoculation.

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Response of Rainfed Blackgram to Planting Geometry and Nitrogen under Late Sown Condition in K.G. Zone of Andhra Pradesh

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ABSTRACT

A field experiment was conducted during the *kharif* season of 1996 and 1997 to study the effect of crop geometry and nitrogen on yield and its attributes of blackgram. The closer row spacings having higher plant population recorded significantly higher grain yield over wider row spacing. Foliar nutrition of 10 kg N/ha in two equal splits at 15 and 23 DAS in addition to normal dose of 20 kg N/ha as basal recorded the maximum yield under late sown conditions. The gross monetary returns and B:C ratio was higher with narrow row spacing under higher nitrogen level of 20 kg N/ha as basal and 10 kg N/ha as foliar spray; and further increase in nitrogen level increased the plant height with less number of pods which resulted into lower grain yield as well as monetary returns.

Key words : Blackgram, Crop geometry, Nitrogen, Yield.

Blackgram is an important pulse crop usually grown as rainfed rainy season with a very rare or no use of fertilizer and proper crop geometry. The productivity of rainfed crop can be increased with the augmentation of agronomic practices, viz., application of fertilizers particularly nitrogenous one and proper row spacing. Although, the technology is available for normal sowings, there is lack of information for late sown condition, as it has become a commonly phenomena due to delayed onset of monsoon in recent times. Hence, the present investigation was undertaken to determine the suitable row spacing and nitrogen requirement for rainfed blackgram in vertisols of K.G. Zone of Andhra Pradesh under late sown condition.

MATERIAL AND METHODS

A field trial was conducted under rainfed conditions during *kharif* season of 1996 and 1997 at the Regional Agricultural Research Station of Acharya N.G. Ranga Agricultural University, Lam, on clay soil having 210, 15 and 425 kg/ha available N, P₂O₅ and K₂O respectively, and pH 8.1. Treatments were laid out in split plot design

with four replications, arranging three crop geometries (20 x 10 cm, 25 x 10 cm and 30 x 10 cm with 5 x 10⁵, 4 x 10⁵ and 3.3 x 10⁵ plants/ha) in main plots and three levels of nitrogen (20 kg N/ha as basal; 20 kg N/ha as basal and 10 kg N/ha as foliar spray; and 30 kg N/ha as basal and 10 kg N/ha as foliar spray) in sub plots. The seeds of blackgram cultivar LBG 623 were sown as per treatments on 16th August in 1996 and 19th August in 1997. A basal dose of 40 kg P₂O₅/ha and nitrogen as per treatments was applied. Urea at 2% conc. was used for foliar application at 15 and 23 days after sowing.

The rainfall received during crop season was 642.8 mm in 25 rainy days and 359.7 mm in 18 rainy days in two consecutive years.

RESULTS AND DISCUSSION

Crop Geometry

Row spacing had a significant response on grain yield. The grain yield recorded under narrow row spacing i.e. 20 x 10 cm and 25 x 10 cm were statistically at par but superior to wider row spacing during both the years (Table 1). Though all the yield attributes were statistically

Table 1 : Effect of crop geometry and nitrogen on yield attributes, seed yield and economics of blackgram under late sown condition.

Treatments	Plant height (cm)		No. of pods/plant		100 seed weight (g)		Grain yield (kg/ha)		Gross Monetary returns (Rs/ha)		Benefit cost ratio on mean	
	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
Crop geometry												
20x10cm (5x10 ⁵ plants/ha)	29.0	27.5	13.4	11.7	3.50	3.48	374.5	303.4	5423	5423	1.05	1.05
25x10cm (4x10 ⁵ plants/ha)	28.4	27.4	14.2	12.5	3.66	3.61	367.6	308.3	5408	5408	1.05	1.05
30x10cm (3.3x10 ⁵ plants/ha)	27.3	26.7	14.0	12.6	3.77	3.70	274.1	248.1	4178	4178	0.81	0.81
SEM±C.D. (p=0.5)	NS	NS	NS	NS	NS	NS	31.2	23.5	323	323	0.07	0.07
Nitrogen												
20 kg/ha as basal	26.6	25.6	13.0	11.5	3.50	3.46	315.6	268.9	4646	4646	0.93	0.93
20 kg/ha as basal and 10 kg/ha as foliar spray	28.1	27.7	14.6	12.8	3.63	3.63	363.0	303.5	5333	5333	1.03	1.03
30 kg/ha as basal and 10kg/ha as foliar spray	30.0	28.4	14.1	12.4	3.73	3.71	337.5	287.4	5000	5000	0.95	0.95
SEM±C.D. (p=0.5)	2.7	1.7	1.3	0.8	NS	NS	38.1	25.1	381	381	0.06	0.06
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Y1		1996.	Y2		1997						

at par, the higher plant population under narrow row spacing contributed higher grain yield. Similar results were also reported by Ashok kumar and Sharma (1989); and Suresh Tomar and Tiwar (1990). The gross monetary returns and benefit cost ratio was significantly higher with closer row spacing as compared to wider row spacing.

The highest significant grain yield was recorded with 20 kg N/ha as basal and 10 kg N/ha as foliar spray during both the years, which was also evident by number of pods/plants. There was a significant decline in grain yield on further increase in nitrogen level, which only led to more plant height with less number of pods/plant. The similar response to nitrogen was recorded by Mathan *et al.*, (1996). Foliar nutrition of 10 kg N/ha at 15 and 23 DAS in addition to the normal dose of 20 kg N/ha as basal application gave significantly highest gross monetary returns as well as benefit : cost ratio.

Therefore, it is concluded that the Blackgram crop grown at 25 x 10 cm spacing with 10 kg N/ha as foliar spray in addition to the normal dose of 20 kg N/ha gave higher grain yield and maximum monetary returns per unit area in vertisols of K.G. Zone in Andhra Pradesh under late sown condition as a rainfed crop.

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Sustainable Groundnut Production Through Integrated Nutrient Management

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ABSTRACT

A field experiment was conducted on sandy loam soils of Agricultural College Farm, Bapatla during *rabi* 2001 to evaluate the influence of integrated nutrient management practices on sustainable production of groundnut crop. The highest number of total and filled pods per plant, shelling per cent, 100 - kernel weight, pod, oil and protein yields were recorded under the treatment receiving 100% RDF + FYM 5t ha⁻¹ but the highest haulm yield was recorded in the treatment receiving 100% RDF + vermicompost 2.5 t followed by the treatment receiving 50% RDF + FYM 5t ha⁻¹ but the highest BCR was noticed in the treatment receiving 50% RDF + FYM 5 t ha⁻¹ + bio-fertilizer seed inoculation.

Key words : INM, RDF, Groundnut, FYM, Vermicompost, Green manure, Pod yield, Oil content and Protein per cent.

Among the nine - oilseed crops, groundnut (*Arachis hypogaea* L.) is an important edible oilseed crop of our country and edible oil economy primarily depends upon groundnut production. Groundnut is cultivated on marginal lands with light textured soils, which mostly suffer from nutrient deficiencies. Nutrient deficiencies might be responsible for the low yields of groundnut in India (Singh *et al.*, 1997). Groundnut removes fairly large quantities of nutrients from the soil. This heavy nutrient depletion though pose a great threat to sustainable yields, yet the use of fertilizers can boost the crop yields, but their prohibitive cost frequently deter farmers from using them in required quantities and in balanced proportions. Therefore, there is a need for developing an efficient nutrient management system, involving use of organic manures, bio-fertilizers and inorganic fertilizers to check nutrient depletion and to maintain soil fertility for sustainable groundnut production. Conjunctive use of organic, inorganic and bio-fertilizers help in achieving higher sustainable yields in

groundnut (Singh *et al.*, 1990). Hence, an attempt was made to study integrated nutrient supply package for sustaining the higher yields in groundnut crop.

MATERIAL AND METHODS

An experiment was conducted with eleven treatments during *rabi* 2001 at the Agricultural College Farm, Bapatla (A.P.) on sandy loam soil having pH 7.0, with 235.0, 18.0 and 310.0 kg ha⁻¹ available N, P₂O₅ and K₂O respectively.

The treatments consisted of

- T₁ - No fertilizers/ manures
- T₂ - 100% RDF
- T₃ - 100% RDF + Vermicompost @ 5t ha⁻¹
- T₄ - 100% RDF + Green manure @ 5t ha⁻¹
- T₅ - 100% RDF + Vermicompost @ 2.5t ha⁻¹
- T₆ - 100% RDF + *Rhizobium* and PSB

Table 1 : Effect of integrated nutrient management on yield attributes and quality parameters of groundnut.

Treatments	Total pods plant ⁻¹	Filled pods plant ⁻¹	Shelling percentage	100 kernel weight (g)	Oil (%)	Oil yield (kg ha ⁻¹)	Protein (%)	Protein yield (kg ha ⁻¹)
RDFo	19.2	13.6	62.0	27.1	45.3	384.4	24.2	199.6
RDF ₁₀₀	26.2	23.5	68.6	34.0	46.1	747.8	24.4	421.0
RDF 1A + FYM _{5t}	33.1	28.6	72.9	36.7	45.9	1007.0	24.9	566.4
RDF 100 + GM _{5t}	26.5	24.6	70.4	34.2	46.2	833.8	24.5	460.0
RDF 100 + VC _{2.5t}	30.7	26.8	71.6	35.6	46.4	939.1	24.9	513.1
RDF 100 + Bio Fert.	28.7	24.1	71.0	35.2	46.2	870.9	24.7	470.7
RDF 50 + PYM _{5t}	26.7	22.1	69.1	34.1	46.2	782.8	24.4	413.9
RDF 50 + GM _{5t}	24.8	21.2	65.5	33.2	45.9	692.3	24.3	364.1
RDF 50 + VC _{2.5t}	26.6	22.7	69.6	34.1	46.1	790.5	24.3	412.5
RDF 50 + Bio Fert.	23.1	20.2	64.7	32.6	45.9	625.8	24.2	327.4
RDF 50 + FYM _{5t} + Bio Fert	32.0	27.7	72.5	36.0	46.7	1001.0	24.8	554.1
SE m _±	1.2	1.4	0.8	1.2	0.45	47.7	0.23	25.2
CD (P=0.05)	3.5	4.2	2.3	3.7	NS	140.8	NS	74.3

T₇ - 50% RDF + FYM@5t ha⁻¹

T₈ - 50% RDF + Green manure @ 5t ha⁻¹

T₉ - 50% RDF+ Vermicompost@2.5t ha⁻¹

T₁₀ - 50% RDF+ *Rhizobium* and PSB

T₁₁ - 50% RDF+FYM@5t ha⁻¹+*Rhizobium* and PSB

The treatments were tested in randomized block design with three replications. Spanish bunch groundnut Cv TMV-2 sown on 22 November 2001 by adopting a spacing of 30 cm x 10 cm was harvested on 8 March 2002. Urea, Single super phosphate and Muriate of potash respectively were the source of NPK. Nitrogen was applied half as basal and the remaining half applied at 30 DAS, while, entire P₂O₅ and K₂O was applied as basal. Farm Yard Manure, Vermicompost and Green manure were incorporated into the soil as per the treatments three weeks before sowing. Gypsum @ 500 kg ha⁻¹ was applied uniformly to all the treatments. The seed was treated with *Rhizobium* and PSB before sowing.

RESULTS AND DISCUSSION

Yield attributes viz., number of filled and total pods per plant, shelling per cent and 100 kernel weight significantly increased with the application of 100% RDF + FYM 5t ha⁻¹ (T₉) closely followed by the treatment receiving 50% RDF + FYM 5t ha⁻¹ + bio-fertilizer seed inoculation (T₁₁). Treatments receiving 50% RDF either through FYM 5t ha⁻¹ (T₇) or vermicompost 2.5 t ha⁻¹ (T₉) performed identically to the treatment receiving 100% RDF alone (T₂).

The increase in yield attributes might be due to improvement in the vegetative growth owing to the application of organic manures. Inorganic fertilizers and seed inoculation with *Rhizobium* and phosphorus solubilizing bacteria favoured flowering, fruiting and translocation of photosynthates to sinks. These findings are in conformity with those of Kumaran *et al.*, (2001). The highest pod yield (3033 kg ha⁻¹) recorded under T₃ treatment was on a par with T₁₁ and T₅ but was significantly superior to rest of the treatments. The pod yield recorded in treatments T₁₁, T₃, T₈, T₅ and T₄ was also statistically at par.

Table 2 : Effect of integrated nutrient management on yield and economics of groundnut.

Treatments	Pod Yield Kg ha ⁻¹	Haulm Yield Kg ha ⁻¹	Gross returns Rs ha ⁻¹	Net returns Rs ha ⁻¹	B :C Ratio
RDFo	1342	2225	16104	4924	0.44
RDF ₁₀₀	2455	3158	30072	17327	1.34
RDF 1A + FYM _{5t}	3033	3419	36396	22651	1.67
RDF 100 + GM _{5t}	2634	3349	31608	17773	1.27
RDF 100 + VC _{2.5t}	2846	3472	34152	13907	0.68
RDF 100 + Bio Fert.	2669	3279	32028	19243	1.50
RDF 50 + PYM _{5t}	2506	3313	29460	16397	1.25
RDF 50 + GM _{5t}	2286	3092	27432	13919	1.03
RDF 50 + VC _{2.5t}	2435	3227	29220	9657	0.49
RDF 50 + Bio Fert.	2085	2871	25008	13105	1.10
RDF 50 + FYM _{5t} + Bio Fert	2958	3465	35496	22393	1.70
SE m±	123.0	155.7			
CD (P=0.05)	362.9	449.5			

The treatments T₇ and T₉ where, 50% RDF was applied either through FYM @ 5 t ha⁻¹ or vermicompost @ 2.5 t ha⁻¹ were statistically at par. There was no added advantage of integration of 100% RDF with the application of vermicompost @ 2.5 t ha⁻¹, bio fertilizer seed inoculation and green manure @ 5 t ha⁻¹, as the treatments T₄, T₅, T₆ were on a par. The increase in pod yield in these treatments might be due to increase in the yield attributing characters. Further the addition of FYM, vermicompost, green manure and bio fertilizers is known to improve the physical, chemical and biological environment of soil resulting in better crop growth and ultimately the yield. The highest haulm yield of (3472 kg ha⁻¹) recorded in T₅ treatment was found significantly superior to T₈, T₁₀ and T₁ treatments. Partitioning of photosynthates in vegetative and reproductive parts goes simultaneously in the later growth phases and hence the performance of the crop in terms of haulm yields. These results are in conformity with the findings of Yadav *et al.*, (1991) Mehta *et al.*, (1995) and Mishra (2001).

While, significant variations were noticed in oil and protein yields, their content in kernels was found to be non significant. The high oil and protein yields (1007.0 kg ha⁻¹ and 566.4 kg ha⁻¹) in T₃ and low yields in T₁ which could be attributed to the fact that oil and protein biosynthesis is a complex process and is always difficult to modulate their contents in plants through management practices. Increased oil and protein yields could mainly be due to cumulative effect of higher pod yield in these treatments. Similar results were also observed by Kachot *et al.*, (2001).

Economics

The highest gross returns (Rs. 36396) were obtained under T₃ treatment, whereas the highest net return was obtained with T₁₁ treatment. The highest gross returns in T₃ treatment was due to higher pod and haulm yield compared to other treatments and the highest net returns in T₁₁ could be due to reduction of 50% recommended dose of fertilizers and higher pod yields equal to that produced under T₃ treatment.

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Effect of Maize + Greengram Intercropping on Yield of Maize and Nutrient Status of Soil

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ABSTRACT

A field study conducted during *rabi* 2002 revealed that grain yield, stover yield and harvest index of maize were significantly influenced by intercropping and NPK levels. Paired row planting of maize with four rows of greengram significantly increased the productivity of the system. Higher yield was obtained due to application of 25% extra over RDF to maize in intercropping indicating the need for higher fertilization to intercropping to meet the fertilizer demands of both the crops. Introduction of greengram as an intercrop in maize showed improvement in the N status of the soil, and reduction in P & K status.

Key Words: Cereal + Legume intercropping, Soil nutrient status.

Maize is an exhaustive, cereal crop and require large quantity of fertilizers, particularly nitrogenous, which is one of the problems of marginal farmers in India due to increased cost under tremendous energy crisis under sole crop. For efficient use of inter row space; legumes when introduced not only help in the utilization of atmospheric nitrogen being fixed by it in the current growing season, but also help in residual nutrient build up of the soil. However, nutrient management in intercropping system is more complex than individual crops and recommendation for individual crop in a system often proves uneconomic. Therefore, in a system approach, the crops that respond most in the intercropping system should only be fertilized and allow the component crops to make use of the applied fertilizers. Keeping this in view, the present investigation was taken up to evaluate the productive performance and soil NPK status of maize + greengram intercrop system.

MATERIAL AND METHODS

A field investigation was conducted during *rabi* 2002 at The Agricultural College Farm,

Bapatla, on clay loam soil having pH-8.1 with low in organic carbon (0.40%), available nitrogen (150 kg ha^{-1}), medium available phosphorus (52 kg ha^{-1}) and high available potassium (920 kg ha^{-1}). Three main treatments comprising I_1 - sole crop of maize, I_2 - Normal planting of maize intercropped with four rows of greengram, I_3 - paired planting of maize intercropped with two rows of greengram and three sub treatments consisting of F_1 - 125% RDF to Maize, F_2 - 100% RDF to Maize and F_3 - 75% RDF to Maize were tested in split plot design replicated thrice. Nitrogen, phosphorous and potassium were applied as per the treatments through urea, Single super phosphate and Muriate of potash respectively. Entire quantity of P_2O_5 and K_2O was applied basally, while nitrogen was applied in three equal splits viz., basal, knee high and tasselling stages. Recommended agronomic practices and plant protection measures were followed. The data on yield and yield attributes collected on randomly selected plants as well as soil samples were analyzed using standard methods.

Table - 1 Grain yield (kg ha⁻¹) Stover Yield (kg ha⁻¹) and Harvest Index of maize (rab) as influenced by intercropping and fertility levels

Intercropping treatments	Fertility levels													
	Grain yield (kg ha ⁻¹)							Stover Yield (kg ha ⁻¹)						
	75% RDF	100% RDF	125% RDF	Mean	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF	Mean	75% RDF	100% RDF	125% RDF
Sole maize	2427	3420	3898	3248	4530	5589	5998	32.18	39.83	44.07	5372	34.48	41.78	40.27
Normal planting of maize + 2 rows of greengram	2677	3823	4554	3684	4677	5949	6647	36.22	42.78	46.84	5757	39.83	44.07	38.69
Paired planting of maize + 4 rows of greengram	2952	4142	5118	4071	4952	6308	7166	34.29	41.46	43.73	6142	36.22	42.78	41.94
Mean	2685	3795	4523		4719	5949	6603							
	SEm ±	CD (0.05)	CV (%)		SEm ±	CD (0.05)	CV (%)	SEm ±	CD (0.05)	CV (%)		SEm ±	CD (0.05)	CV (%)
Intercropping	136.30	535.00			98.59	387.01		0.98	NS			2.12	6.58	16.1
Fertility levels	166.13	511.90	13.00		144.60	445.68	7.53							
S at M		NS				NS			NS				NS	
M at S		NS				NS			NS				NS	

Table - 2 Residual soil fertility status as influenced by intercropping and fertility levels

Intercropping treatments	Fertility levels											
	Nitrogen						Phosphorus					
	75% RDF	100% RDF	125% RDF	Mean	75% RDF	100% RDF	125% RDF	Mean	75% RDF	100% RDF	125% RDF	Potassium Mean
Sole maize	138.8	150.0	157.9	148.9	47.6	53.0	60.0	53.5	768.6	804.6	881.0	818.1
Normal planting of maize + 2 rows of greengram	143.4	152.7	162.7	152.9	46.0	47.0	53.0	48.6	728.3	786.6	755.0	756.6
Paired planting of maize + 4 rows of greengram	156.4	164.2	164.7	161.8	43.3	50.6	51.6	48.5	741.6	692.3	800.3	744.7
Mean	146.2	155.6	161.8		45.6	50.2	54.8		746.2	761.2	812.1	
	SEm $\pm$	CD (0.05)	CV (%)		SEm $\pm$	CD (0.05)	CV (%)		SEm $\pm$	CD (0.05)	CV (%)	
Intercropping	5.75	NS			2.83	NS			27.68	NS		
Fertility levels	6.40	NS	12.4		3.28	NS	19.6		37.55	NS	14.6	
S at M		NS				NS				NS		
M at S		NS				NS				NS		

RESULTS AND DISCUSSION

Grain yield of maize significantly increased in paired row planting of maize + four rows of green gram (4071 kg ha^{-1}), which was 10.5 per cent higher than the normal planting of maize + two rows of greengram and 22.3 per cent higher than the sole maize (Table 1). Higher yields in paired planting of maize was also reported by Rathore *et al.*, (1980) and Singh and Singh (2001).

Among the fertility treatments, 125 per cent RDF to maize recorded the highest grain yield (4523 kg ha^{-1}) which was 19 per cent higher than 100 per cent RDF to maize and 68.4 per cent higher than 75 per cent RDF to maize. Similar results were also reported by Chakor and Kumar (1988) and Kumar *et al.*, (2002). Additional yield obtained due to 25 per cent extra RDF to maize in intercrop situation resulted in increased yield of base crop without any competitive effect between both the crops for their nutrient requirements. Stover yield of maize also followed the similar trend as that of grain yield.

Harvest index of maize though significantly influenced by fertility levels was not affected by either intercropping treatments or interaction between fertility levels and intercropping treatments. Harvest index of maize was found to increase progressively with increase in fertility level. The highest harvest index was obtained with 125 per cent RDF to maize, which was on par with 100 per cent RDF but significantly superior to 75 per cent RDF. However, 100 per cent RDF to maize was significantly superior to 75 per cent RDF to maize. Among all the treatments, 75 per cent RDF to maize recorded the lowest harvest index (Table 1).

Maize being an exhaustive feeder, utilized more N, rendering the soil poor in its nitrogen content. However, greengram and maize

intercropping situation improved the N status of soil by 5 kg ha^{-1} (Table 2). Greengram being a legume could fix atmospheric nitrogen through their root nodules. Paired planting of maize + four rows of greengram recorded higher residual soil nitrogen status due to increase in legume population under this treatment are in agreement with those reported by Sharma and Choubey (1991). Application of 125 per cent RDF to maize in intercropping resulted in higher nitrogen nutrient status of the soil. Among all the treatments, sole maize recorded the lowest residual soil nitrogen.

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Correlation and Path Analysis of Grain Yield and Physiological Attributes in Greengram (*Vigna radiata* (L.) Wilczek).

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ABSTRACT

Twenty one F_4 progenies derived from a 7 x 7 diallel cross of greengram were evaluated to assess the role of physiological parameters in determining the grain yield. Correlation analysis revealed strong positive association of biomass at harvest, NAR and RGR between 35-50 DAS, CGR between 35-50 DAS and 50 DAS, maturity and HI with grain yield and also among themselves. Path coefficient analysis suggested that NAR between 20-35 DAS and 50 DAS and maturity showed high direct effects on grain yield which could be considered as a selection criteria for improving seed yield in greengram.

Key Words: Greengram, Grain Yield, Physiological Attributes, Correlation, Path Analysis

Greengram is one of the most widely cultivated Asiatic *Vigna* species grown in diverse soils and climatic regions of Andhra Pradesh. Low yield potential of greengram genotypes is attributed due to short growth duration, unfavourable canopy structure and less efficiency of physiological parameters. Selection based on yield and its components coupled with physiological parameters is found to be effective in isolation of superior genotypes with high yield potential in later segregating generations. A knowledge of physiological parameters and their association with yield is essential in order to formulate appropriate selection criteria for yield improvement in greengram. Though character associations for yield and its components (sink) in greengram have been reported by several workers, but the information on *inter se* associations of physiological attributes (source) are scanty and very meagre in this crop. Hence, an attempt was made to study correlation coefficients along with the path analysis of physiological attributes for isolation of desirable genotypes of greengram.

MATERIAL AND METHODS

Seven parents viz, COGG 2, ML 267, Pusa 105, RMG 275, PDM 89-221, LGG 460 and LGG 410 and their 21 t_4 progenies were grown in RBD with three replications at S.V.Agricultural College Farm, Tirupati during *rabi* 1998. Each entry was sown in 2 rows of 3m length with a spacing of 30 x 15 cm. Observations were recorded on five randomly selected plants in each row for growth analysis covering all growth phases (20, 35, 50 DAS and maturity) and were used to calculate Crop Growth Rate (CGR), Relative Growth Rate (RGR), Net Assimilation Rate (NAR), Leaf Area Index (LAI), Leaf Area Ratio (LAR), Specific Leaf Area (SLA), Specific Leaf Weight (SLW) and Harvest Index (HI) by using the formulae proposed by Radford (1967) and Watson (1952).

RESULTS AND DISCUSSION

The association of physiological attributes with grain yield in F_4 progenies revealed strong positive association of CGR, NAR and RGR between 35-50 DAS, CGR between 50 DAS

Table -1 Phenotypic (r_p) correlation coefficients among physiological attributes in 21 F₄ Progenies of greengram

Character	OGR			RGR			NAR			LAI			At Maturity
	20-35DAS	35-50DAS	50 DAS-Mat	20-35 DAS	35-50DAS	50 DAS-Mat	20-35 DAS	35-50 DAS	50 DAS-Mat	20 DAS	35 DAS	50 DAS	
Biomass at Harvest	0.16.05	0.6980**	-0.5160*	0.131	0.6768	0.0606	0.2796	0.6981**	-0.6468**	-0.1927	-0.2984	0.6877**	0.6987
OGR	20-35 DAS	-0.0419	-0.2352	0.5785**	-0.4707*	0.2663	0.7534**	-0.2818	-0.1642	-0.0895	-0.1721	0.4265	0.4241
	35-50 DAS	-0.5725**	-0.0341	-0.1139	0.7108**	0.1241	0.1002	0.7044**	-0.4857*	-0.1928	-0.0090	0.5217*	0.5285
	50DAS-Mat				-0.3822	-0.0606	-0.4110	-0.4052	0.4361*	0.3143	-0.0129	0.5832**	-0.5848**
RGR	20-35 DAS				-0.2989	0.1021	0.4967*	-0.1580	-0.0681	-0.2047	-0.3281	0.2599	0.2525
	35-50 DAS					-0.0978	-0.2951	0.8603**	-0.4319	-0.1475	0.0081	0.3185	0.3310
	50DAS-Mat						0.0318	-0.0667	-0.2445	0.4295	-0.0605	0.1488	0.1406
NAR	20-35 DAS							-0.0845	-0.3506	-0.2797	-0.4579*	0.5291*	0.5266*
	35-50 DAS								-0.4616*	-0.1921	-0.0996	0.2866	0.3017
	50DAS-Mat									0.0541	0.2469	0.5440*	-0.5412*
LAI	20 DAS										0.0551	0.1273	-0.1479
	35 DAS											0.3645	-0.3534
	50 DAS												0.9987*
LAR	20 DAS												
	35 DAS												
	50DAS												
SLA	20 DAS												
	35 DAS												
	50DAS												
SLW	20 DAS												
	35 DAS												
	50DASX												
HI	20 DAS												
	35 DAS												
	50DASX												

* Significant at P = 0.05

** Significant at P = 0.01

(Contd.....)

maturity with grain yield (Table 1). These characters also showed positive *inter-se* correlations. This indicates that higher dry matter production per plant is an indication of accumulation of more carbohydrates during the vegetative phase and its subsequent transformation in reproductive parts during later stages resulting in more seed yield the significant positive of association of RGR, NAR and CGR with grain yield in greengram was revealed by several workers (Gill *et al.*, 1992, Singh and Singh, 1996). Similarly positive association of dry matter at harvest (Chandrababu *et al.*, 1997) harvest index (Patil *et al.*, 1996) with grain yield was also reported.

Among F_4 progenies biomass per plant displayed significant positive association with LAI at maturity and NAR and CGR between 35-50 DAS. Similarly, CGR between 20-35 DAS expressed significant positive correlation with NAR and RGR between 20-35 DAS, CGR between 35-50 DAS with RGR and NAR between 35-50 DAS, where as CGR between 50 DAS maturity registered significant positive association with SLA at 20 DAS and NAR between 50 DAS-maturity in F_4 progenies.

It was observed that RGR between 20-35 DAS and 35-50 DAS displayed significant positive association with NAR between 20-35 DAS while NAR between 20-35 DAS correlated positively with LAI at 50 DAS and maturity. Similarly, LAI at 20 and 25 DAS revealed significant positive association with SLA at 20 DAS and LAR at 35 DAS, while LAI at 50 DAS and maturity were positively correlated with SLA at maturity and 50 DAS. On contrary, LAR at 20 DAS recorded positive association with SLA at 20 DAS, where as LAR at 35 DAS revealed significant positive association with SLW at 50 DAS and SLA at 35 DAS. LAR at 50 DAS registered significant association with SLA at 50 DAS and maturity and SLW at 50 DAS with SLW

at 35 DAS.

The significant positive association between CGR and NAR in soybean (Buttery, 1969) and CGR with LAI in pea (Eastin and Gritton, 1969) were reported earlier. Similarly, significant positive association between RGR and NAR was also revealed in blackgram (Pandey *et al.*, 1978) and mungbean (Gopal Singh and Jai Narain Singh, 1981) and were in conformity with the results of the present study. It was reported that NAR and LAR might have some threshold limits on increase of yield and could be of little value in selection of high yielding elite genotypes (Manian *et al.*, 1989). Harvest Index had positive correlation with grain yield but negatively associated with biological yield. This relation can be reverted by selecting for efficient dry matter distribution using recombination breeding or through induced mutations.

Path analysis revealed the highest positive direct contribution to yield by LAI at maturity followed by NAR between 50 DAS - maturity, harvest index, biomass at harvest, SLA at 20 DAS, RGR between 35-50 DAS and LAR at 50 DAS (Table 2). On contrary, CGR between 50 DAS - maturity and NAR between 35-50 DAS expressed negative direct effects on yield in F_4 progenies. The positive direct effects of different attributes on yield were reported for CGR and RGR (Yadava *et al.*, 1979) in greengram, for NAR and LAR in horsegram (Manian *et al.*, 1989) and for biomass at harvest, SLA and HI (Patil *et al.*, 1996) in greengram which further supported findings of the present study. High positive indirect effects of CGR between 35-50 DAS via, LAI at maturity, CGR between 50 DAS-maturity via LAI at 50 DAS and NAR between 35-50 DAS via, LAI at maturity were observed. Contrarily, negative indirect effects were observed in case of NAR between 50 DAS-maturity through LAI at 50 DAS, 35 DAS and LAR at 20 DAS. The critical analysis of character associations indicated that

Table 1 : Phenotypic (r_p) correlation coefficients among physiological attributes in 21 F_4 Progenies of greengram

Character	LAR				SLA				SLW				HI	Grain yield per plant				
	20 DAS		35 DAS		50 DAS		At Maturity		20 DAS		35 DAS				50 DAS		At Maturity	
Biomass at Harvest		-0.1092	-0.2527	-0.1780	0.1562	-0.0804	0.0975	0.1452	0.1191	0.1302	-0.1047	0.1620	-0.1504	-0.0244	0.7537			
	20-35 DAS	0.1202	-0.6473**	0.2547	0.3262	-0.0569	-0.1702	0.2485	0.3956	0.0351	0.0708	-0.3095	-0.3847	-0.1078	0.0739**			
	CGR	35-50 DAS	-0.0244	0.0096	-0.2907	0.0531	-0.1137	0.2534	0.0775	0.0508	0.2133	-0.2310	-0.0457	-0.0072	0.2178	0.7329**		
	50 DAS-Mat	0.3566	0.2491	0.1108	-0.2455	0.4593*	-0.1750	-0.2658	-0.2919	-0.4987	0.1699	0.3348	0.2793	-0.2289	0.5409*			
RGR	20-35 DAS	0.3169	-0.4856*	0.1300	0.1508	-0.1055	-0.1461	0.1720	0.2081	0.0907	0.0547	-0.1648	-0.2473	-0.0055	0.0628			
	35-50 DAS	-0.2028	0.3032	-0.4435*	-0.1479	-0.0543	0.3177	-0.1135	-0.2116	0.0978	-0.2812	0.1302	0.1927	0.1361	0.6276**			
	50 DAS-Mat	0.3450	-0.1863	0.1111	0.1629	0.3469	-0.1153	0.0592	0.0722	-0.3816	0.0607	-0.0909	-0.1133	0.0020	0.1088			
	NAR	20-35 DAS	0.1128	-0.7936**	0.2459	0.3860	-0.2674	-0.2554	0.4194	0.4099	0.2419	0.1842	-0.4566**	-0.3930	-0.0026	-0.2195		
LAI	35-50 DAS	-0.1727	0.0989	-0.5509**	-0.2394	-0.0653	0.2463	-0.1952	-0.3035	0.1424	-0.2249	0.1712	0.3134	0.1806	0.6575**			
	50 DAS-Mat	0.1413	0.2737	0.0173	-0.2888	0.1271	-0.0621	-0.2409	0.0255	-0.1388	0.0454	0.2639	0.1249	-0.2100	-0.6458**			
	20 DAS	0.5492	0.1010	0.1587	0.0061	0.6535**	-0.2121	-0.1417	-0.1901	-0.6268**	0.1697	0.1116	-0.0233	-0.1185	-0.1940			
	35 DAS	-0.2528	0.7358	-0.2963	-0.2889	-0.0146	0.6027	-0.3719	0.1901	0.1010	-0.5302*	0.3537	0.1807	0.1902	0.1510			
LAR	50 DAS	-0.0961	-0.5235	0.3918	0.6828**	-0.1953	-0.1993	0.6507**	0.6847**	0.1624	0.1556	-0.6647**	-0.6360**	-0.0079	-0.5800**			
	At Maturity	-0.1223	-0.5129	0.3722	0.6680**	-0.2064	-0.1860	0.6388**	0.6496**	0.1742	0.1442	-0.6517**	-0.6214**	-0.011	-0.5893**			
	20 DAS		0.1296	0.1228	-0.0648	0.5554**	-0.2078	-0.1588	-0.0015	-0.5369*	0.1077	0.1022	-0.0243	-0.1778	0.2126			
	35 DAS			-0.3861	-0.4422*	0.1044	-0.5162*	-0.4775*	-0.4408*	-0.0806	-0.4048	0.5195*	0.4066	0.1167	0.1656			
SLA	50 DAS				-0.8155**	-0.0178	-0.4063	0.7713**	0.7896**	-0.1375	0.3923	-0.7463**	-0.7406**	-0.1613	-0.2059			
	At Maturity					-0.1316	-0.2981	0.8491**	0.8445**	0.0046	0.2702	-0.8703**	-0.8020**	-0.0236	-0.1409			
	20 DAS					0.0034	-0.3170	-0.1614	-0.1614	-0.8190**	-0.0955	0.3114	0.1876	-0.3789	-0.2172			
	35 DAS						-0.4739*	-0.2484	-0.2484	0.1050	-0.8951**	0.4177	0.1834	0.1561	0.1027			
SLW	50 DAS							0.8208**	0.8208**	0.1343	0.4959*	-0.9329**	-0.7937**	-0.0791	0.0950			
	At Maturity									0.1140	0.2282	-0.8545**	-0.9465**	-0.1321	0.0334			
	20 DAS										-0.0721	0.1865	-0.1255	0.2870	0.2758			
	35 DAS											-0.4129	-0.1914	-0.1759	-0.1595			
HI	50 DAS												0.8218**	0.0603	-0.1083			
	At Maturity													0.1325	-0.0399	0.5079*		

Table 2 : Phenotypic (p) path coefficients among grain yield physiological attributes in 21 F₄ Progenies of greengram

Character	Biomass at Harvest			CGR			RGR			NAR			LAI			At Maturity
	20-35 DAS	35-50 DAS	50 DAS	20-35 DAS	35-50 DAS	50 DAS	20-35 DAS	35-50 DAS	50 DAS	20-35 DAS	35-50 DAS	50 DAS	20-35 DAS	35-50 DAS	50 DAS	
Biomass at Harvest	0.3742	0.0265	0.1490	0.0654	-0.0017	0.2140	-0.0013	-0.0143	-0.0152	0.0900	0.0126	-0.0002	-2.7102	-0.0002	-2.7102	2.8552
20-35 DAS	0.0601	0.1652	-0.0089	0.0252	-0.0077	-0.1488	-0.0057	-0.0386	0.0061	0.0229	0.0058	-0.0001	-1.6807	-0.0001	-1.6807	1.6118
35-50 DAS	0.2612	-0.0069	0.2134	0.0614	0.0005	0.2248	-0.0026	-0.0051	-0.0152	0.0676	0.0126	-0.0040	-2.0562	-0.0040	-2.0562	2.0084
50 DAS	-0.1931	-0.0388	-0.1222	-0.4336	0.0015	-0.1212	0.0013	0.0211	0.0088	-0.0607	-0.0205	-0.5409	2.2983	-0.5409	2.2983	-2.2225
RGR	0.0490	0.0955	-0.0073	0.0122	-0.0133	-0.0945	-0.0022	-0.0255	0.0034	0.0095	0.0134	-0.0002	-1.0243	-0.0002	-1.0243	0.9597
20-35 DAS	0.2533	-0.0777	0.1517	0.0411	0.0040	0.3182	0.0021	0.0151	-0.0187	0.0601	0.0096	-0.0000	-1.2554	-0.0000	-1.2554	1.2579
35-50 DAS	0.0227	0.0440	0.0265	0.0065	-0.0014	-0.0309	-0.0213	-0.0016	0.0015	0.0340	-0.0028	0.0000	-0.5866	0.0000	-0.5866	0.5342
NAR	0.1046	0.1244	0.0214	0.0441	-0.0066	-0.0933	-0.0007	-0.0512	0.0018	0.0488	0.0183	-0.0003	-2.0583	-0.0003	-2.0583	2.0012
20-35 DAS	0.2612	-0.9465	0.1495	0.0435	0.0021	0.2721	0.0014	0.0043	-0.0217	0.0642	0.0126	-0.0001	-1.1294	-0.0001	-1.1294	1.1464
35-50 DAS	0.3948	-0.4462	0.2482	0.2132	0.0267	-0.9034	-0.0369	0.0852	0.1061	1.3193	0.0680	-0.3031	-2.8279	-0.3031	-2.8279	2.9163
LAI	-0.0721	-0.0148	-0.0412	-0.0337	0.0027	-0.0466	-0.0092	0.0143	0.0042	-0.0075	-0.0654	0.0000	0.5017	0.0000	0.5017	-0.5621
20 DAS	-0.1117	-0.0284	-0.0019	0.0014	0.0044	0.0026	0.0013	0.0235	-0.0022	-0.0344	-0.0036	0.0088	1.4367	-0.0036	1.4367	-1.3430
35 DAS	0.2573	0.704	0.1113	0.0626	-0.0035	0.1007	-0.0032	-0.0271	-0.0062	0.0757	-0.0083	-0.5803	-3.9412	-0.0083	-3.9412	3.7954
50 DAS	0.2614	0.0700	0.1128	0.0628	-0.0034	0.1047	-0.0030	-0.0270	0.0066	0.0753	0.0097	-0.5890	-1.9361	0.0097	-1.9361	3.8003
At Maturity	-0.0409	0.0198	-0.0521	-0.0383	-0.0042	-0.0641	-0.0074	0.0058	0.0038	-0.0197	-0.0359	-0.0002	0.3789	-0.0002	0.3789	-0.4646
LAR	-0.0946	-0.1069	0.0030	-0.0267	0.0065	0.0959	0.0040	0.0407	-0.0022	-0.0381	-0.0066	0.3318	2.0631	-0.0066	2.0631	-1.9493
20 DAS	-0.0666	0.0421	-0.0620	-0.0119	0.0617	-0.1403	-0.0024	-0.0126	0.0120	-0.0024	-0.0104	-0.0002	-1.5443	-0.0002	-1.5443	1.4145
35 DAS	0.0584	0.0539	0.0113	0.0263	-0.0020	-0.0488	-0.0035	-0.0198	0.0052	0.0402	-0.0004	-0.0002	-2.4091	-0.0004	-2.4091	2.5386
At Maturity	-0.0301	-0.0094	-0.0243	-0.0493	0.0014	-0.0172	-0.0074	0.0137	0.0014	-0.0177	-0.0427	-0.0000	0.7698	-0.0000	0.7698	-0.7843
SLA	0.0365	-0.0281	0.0541	0.0188	0.0019	0.1005	0.0025	0.0131	-0.0054	0.0086	0.0139	0.0005	0.7856	0.0005	0.7856	-0.7068
20 DAS	0.0543	0.0410	0.0165	0.0285	-0.0023	-0.0359	-0.0013	-0.0215	0.0042	0.0335	0.0093	-0.0003	-2.5643	-0.0003	-2.5643	2.4277
35 DAS	0.0446	0.0653	0.0108	0.0313	-0.0028	-0.0669	-0.0015	-0.0210	0.0066	0.0063	0.0017	-0.0001	-2.6197	-0.0001	-2.6197	2.4688
At Maturity	0.0487	0.0058	0.0455	0.0535	-0.0012	0.0339	0.0081	-0.0124	-0.0031	0.0193	0.0410	0.0001	-0.6401	0.0001	-0.6401	0.6619
SLW	-0.0392	0.0117	-0.0493	-0.0182	-0.0007	-0.0889	-0.0013	-0.0094	0.0049	-0.0063	-0.0111	-0.0004	-0.6131	-0.0004	-0.6131	0.5481
20 DAS	-0.0606	-0.0511	-0.0098	-0.0359	0.0022	0.0412	0.0019	0.0234	-0.0037	-0.0367	-0.0073	0.0003	2.6196	-0.0073	2.6196	-2.4768
35 DAS	-0.0563	-0.0635	-0.0015	-0.0300	0.0033	0.0609	0.0034	0.0201	-0.0068	-0.0174	0.0015	0.0001	2.5066	0.0015	2.5066	-2.3616
At Maturity	-0.0091	-0.0178	0.0465	0.0246	0.0001	0.0430	-0.0000	0.0001	-0.0039	0.0292	0.0077	0.0001	0.0312	0.0001	0.0312	-0.0419

* Significant at P = 0.05

** Significant at P = 0.01

(Contd.....)

Table 2 : Phenotypic (p) path coefficients among grain yield per plant and physiological attributes in 21 F4 progenies of greengram

Character	CGR				NAR				LAI			HI	Correlation with grain yield per plant (r)	
	20DAS	35DAS	50DAS	At Maturity	20DAS	35DAS	50DAS	At Maturity	20DAS	35DAS	50DAS			At Maturity
Biomass at Harvest	-0.0006	0.0163	-0.0483	-0.0010	-0.0265	-0.0330	-0.0100	-0.0140	0.0278	0.0111	-0.0199	0.0313	-0.0133	0.7537**
CGR	20-35 DAS	0.0007	0.0416	0.0891	-0.0020	-0.1290	0.0577	-0.0171	-0.0467	0.0075	-0.0075	0.0800	-0.0590	0.0739**
	35-50 DAS	-0.0013	-0.0006	-0.0788	-0.0003	-0.0375	-0.0859	-0.0053	-0.0060	0.0456	-0.0244	-0.0056	0.0015	0.7329**
	50 DAS Mat	0.0020	-0.0160	0.0301	0.0015	0.1515	0.0593	0.0182	0.0344	-0.0166	-0.0180	0.0412	-0.0581	0.5409*
RGR	20-35 DAS	0.0017	0.0312	0.0353	-0.0009	-0.0348	0.0495	-0.0118	-0.0245	0.0194	-0.0058	0.0514	-0.0030	0.0628
	35-50 DAS	-0.0011	-0.0195	-0.1203	0.0009	-0.0179	-0.1077	0.0078	0.0250	0.0209	0.0298	-0.0401	0.0745	0.6276**
	50 DAS Mat	0.0019	0.0120	0.0301	-0.0010	0.1145	0.0391	-0.0041	-0.0085	-0.0816	-0.0064	0.0236	0.0011	0.1088
NAR	20-35 DAS	-0.0006	0.0511	0.0667	0.0024	-0.0882	0.0866	-0.0288	-0.0483	0.0517	-0.2390	0.0817	-0.0014	-0.2195
	35-50 DAS	-0.0009	-0.0064	-0.1494	0.0015	-0.0215	-0.0835	0.0134	0.0358	0.0305	0.0238	0.0211	-0.0651	0.6575**
	50 DAS Mat	-0.0614	0.1794	0.0011	-0.0666	0.0539	-0.0418	-0.6073	0.0873	-0.2084	-0.0263	0.0366	-0.2160	-0.6458**
LAI	20 DAS	0.0030	-0.0065	0.0431	-0.0000	0.2157	0.4599	0.0097	-0.0030	-0.1340	-0.0180	0.0137	0.0048	-0.1940
	35DAS	-0.0014	-0.0473	-0.0804	0.0018	-0.0048	-0.2043	0.0255	0.0224	0.0216	0.0561	0.0435	-0.0376	0.1510
	50 DAS	-0.5805	0.0337	0.1063	-0.0042	-0.0645	0.0676	-0.0447	-0.0784	0.0347	-0.0165	0.0818	0.1322	-0.5800**
At Maturity	-0.5900	0.0330	0.1010	-0.0041	-0.0681	0.0630	-0.0439	-0.0786	0.0372	-0.0153	-0.0802	0.1292	-0.0060	-0.5893**
LAR	20 DAS	0.0055	0.0083	0.0333	0.2130	0.1833	0.0704	0.0109	0.2128	0.1148	-0.0114	0.0126	0.0650	0.2126
	35DAS	-0.0007	-0.0643	-0.1047	0.0027	0.0344	-0.1750	0.0328	0.0520	-0.0172	0.0428	0.0640	-0.0845	0.1656
	50DAS-Mat	-0.0007	0.0248	0.2712	0.0050	-0.0059	0.1378	-0.0530	-0.0931	-0.0294	-0.0415	-0.0919	0.1539	-0.0639
At Maturity	0.0004	0.0285	0.2212	-0.0061	-0.0434	0.1011	-0.0583	-0.0996	0.0095	-0.0286	-0.1071	0.1667	-0.0129	-0.1409
SLA	20 DAS	0.0031	-0.0067	-0.0048	0.0008	0.3300	-0.0113	0.0218	0.0190	-0.1751	0.0101	0.0383	-0.0390	-0.2073
	35 DAS	-0.0011	-0.0332	-0.1102	0.0018	0.0110	-0.3390	0.0325	0.0293	0.0225	0.0947	0.0514	-0.0381	0.1027
	50 DAS-Mat	-0.0009	0.0307	0.2092	-0.0052	-0.1046	0.1607	-0.0687	-0.0968	0.0287	-0.0525	-0.1148	0.1629	0.0950
At Maturity	-0.0000	0.0284	0.2142	-0.0052	-0.0533	0.0842	-0.0564	-0.1179	0.0244	-0.0242	-0.1052	0.1967	-0.0723	0.0334
SLW	20 DAS	-0.0029	0.0052	-0.0373	-0.0003	-0.2702	-0.0356	-0.0092	-0.0134	0.2138	0.0076	-0.0230	0.0261	0.2758
	35 DAS	0.0006	0.0260	0.1064	-0.0017	-0.0315	0.3035	0.3140	-0.0269	-0.0154	-0.1058	-0.0508	0.0398	-0.0962
	50 DAS-Mat	0.0006	-0.0334	-0.2024	0.0053	0.1028	-0.1416	0.0641	0.1008	-0.0399	0.0437	0.1231	-0.1708	0.0330
At Maturity	-0.0001	-0.0262	-0.2009	0.0049	0.0619	-0.0622	0.0538	0.1116	-0.0268	0.0203	0.1012	-0.2079	0.0725	-0.0399
HI	0.0010	-0.0075	-0.0437	0.0001	-0.1250	-0.0529	0.0054	0.0156	0.0614	0.0186	0.0074	-0.0275	0.5472	0.5079*

* Significant at P = 0.05

** Significant at P = 0.01

a genotype with higher harvest index, NAR, CGR and biomass at harvest represents an ideal plant type of high yield potential genotypes in greengram.

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Studies on Genetic Divergence in Soybean (*Glycine max* L. Merrill)

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ABSTRACT

Genetic diversity in ninety germplasm lines of soybean was evaluated through D^2 analysis. The clustering pattern revealed no relationship between the genetic divergence and geographical distribution. These genotypes were grouped into nine clusters. Clusters I, V and VII had thirteen genotypes each, while cluster IX had twelve genotypes and cluster II and III had eleven genotypes and cluster II and III had eleven each. Clusters IV, VIII and VI had 8, 7 and 2 respectively. The genotypes falling in cluster IX had the maximum divergence followed by those of clusters VI, V and I. The maximum and minimum divergence was revealed between the clusters VIII and IX and between cluster II and III. Cluster II exhibited maximum mean values for number of pods per cluster. Pods per plant, harvest index and grain yield per plant. Cluster IV recorded maximum mean values for oil percentage while cluster V had high mean protein values. Mean biological yield was highest in cluster VI. Plant height (cm), number of pods per plant, protein content (%) and oil content (%) contributed maximum towards genetic divergence. The best genotypes from different clusters were identified for future crossing programme for improvement of soybean yield and quality.

Key words: Soybean, genetic divergence, D^2 analysis, Genotypes, Clusters.

Soybean is an important grain legume because of its three dimensional utility as pulse, oil seed and vegetable. Development of new varieties largely depends on genetic variability present in the base material for the traits under consideration. (Fehr, 1978). Geographic diversity may not necessarily be related with genetic diversity (Murthy and Arunachalam, 1966). In self - pollinated species the choice of parents for hybridization largely depends on wide adaptation, genetic variability and high yield potential. Hence the present investigation was carried out to elicit information on genetic divergence among ninety soybean germplasm lines with diverse geographic origin.

MATERIAL AND METHODS

The investigation was carried out on 90 diverse germplasm lines at MPKV, Rahuri during Kharif 1999. These lines were raised in completely randomized block design with three replications. The observations on five randomly selected plants in each population were recorded on 15 quantitative characters viz., days to 50%

flowering, days to maturity, plant height at maturity, number of branches per plant, clusters per plant, pods per cluster, pods per plant, seeds per pod, harvest index, mechanical damage, 100 seed weight (g), grain yield per plant (g), protein content (%), oil content (%) and biological yield per plant (g). The data generated was utilized to estimate the genetic divergence and related statistics by using D^2 statistics as suggested by Rao (1952).

RESULTS AND DISCUSSION

The analysis of variance showed existence of significant difference among the germplasm lines for all the characters studied. The D^2 values ranged from 21.2 to 3058.8. The lowest value is between genotypes MACS - 493 and LSB-3, while the highest between VLS-52 and UGM-47. On the basis of divergence ninety genotypes under investigation have been grouped into nine clusters (Table 1). Clusters I, V and VII have been found largest with 13 genotypes followed by IX (12) II and III (11), IV (8), VIII (7) and VI (2). The clustering pattern indicated that

Table 1 :Distribution of ninety genotypes in different clusters

S.No.	Cluster No	No. of genotypes	Genotypes
1	I	13	SL-459, PK-1029, SL-295, PK-1228, DS-59, DS-9801, EC-204, EC-14469, EC-18177, NRC-41, MACS-13, JS-92-22, EC-37109
2	II	11	TS-98-21, MACS-450, MAUS-61, EC-39698, PK-1225, DS-208, JS(SH)93-44, ACPS-187, MAUS-62, DS-15, PSM 96148
3	III	11	MACS-493, LSB-3, MACS-629, MAUS-68, MACS-294, SL-432, SH-84-18, JS-82-14, JS(SH)9301, TS-98-1, DS-12
4	IV	8	NRC-44, DS-149, EC-95225-2, MACS-569, EC-39103, EC-251321, DS-103, JS-79-81
5	V	13	JS-91-12, DS-9802, MAUS-63, DS-141, PK-1223, MAUS-57, EC-2043, ACPS-165, JS-(SH) 93-37, MAUS-2, MACS-58, EC-34039, JS-80-21
6	VI	2	EC-57043, ACPS-158
7	VII	13	Arti, Bragg(C), RAUS-4, EC-34041, DS-205, DS-5, NRC-42, RAUS-43, DS-60, PKV-1, MACS-565, PK-1243
8	VIII	7	PK-1229, Himso-1579, VLS-53, NRC-40, Himso-1578, Himso-1577, VLS-52
9	IX	12	JS-(SH)93-43, ACPS-164, MACS-124, PK-7665, ACPS-147, PSM-96139, ACPS-180, ACPS-156, YELLOW TUR, EC-34386, UGM-47, ACPS-170

Table - 2 : Inter and intra cluster D² values

Cluster No	I	II	III	IV	V	VI	VII	VIII	IX
I	12.139	15.795	14.414	14.631	17.081	24.925	14.819	17.289	26.863
II		11.500	13.054	15.120	15.203	26.416	17.235	22.680	24.356
III			9.793	16.481	14.984	25.345	13.130	18.345	26.897
IV				11.162	14.792	22.120	19.958	23.726	20.977
V					12.692	25.408	20.478	25.443	20.289
VI						13.144	26.163	29.120	30.704
VII							11.712	13.413	32.433
VIII								11.322	37.268
IX									18.070

the tendency of genotypes from diverse geographic locations falling under one cluster revealing no relationship between geographic distribution and genetic diversity. This may be due to free exchange of breeding material from one place to another besides unidirectional selection for a particular trait under the respective domestication. This was in conformity with those of earlier studies. (Raut *et al.*, 1984, Ghatge and Kadu, 1993).

The divergence with in the cluster indicates the divergence among the genotypes falling in the same cluster. On the other hand inter cluster divergence suggest the distance between the genotypes of different clusters. The data suggested maximum distance between the genotypes falling in cluster IX (18.07) followed

by VI (13.144) and V (12.692). While it was least in cluster III (9.79). When the clusters were compared for divergence the maximum distance was observed between clusters VIII and IX (37.268) followed by VII and IX (32.433) and between VI and IX (30.704). On the other hand, it was minimum between clusters II and III (13.054). Genotypes from highly divergent clusters may yield the best parents for an effective crossing programme leading to accumulation of favourable genes into a single genotype. The cluster means were presented in table 3 for different characters. The cluster II recorded high mean value for seed yield per plant (21.187) followed by cluster III (17.506). The highest grain yield in cluster II is accompanied by high mean values for number of pods per

Table - 3 Cluster Means for the Characters Studied

Sl. No	Days to 50% flowering	Days to maturity	Height of plant at maturity (cm)	No. of branches/ plant	No. of clusters/ plant	No. of pods / cluster	No. of pods / plant	No. of seeds/ pod	Harvest Index	% Mechanical damage	100 seed weight (g)	Protein content (%)	Oil content (%)	Biological Yield per plant(g)	Grain yield/ plant(g)
1	37.692	95.256	59.969	3.774	19.790	2.218	44.179	2.171	0.455	2.872	14.849	12.791	34.605	17.54	28.234
2	38.818	97.333	67.894	4.424	26.958	3.144	84.670	2.091	0.486	3.275	13.735	21.187	35.438	16.14	43.72
3	37.303	98.000	59.648	4.609	24.518	2.821	67.142	2.072	0.438	2.816	13.672	17.506	39.299	18.193	40.502
4	38.917	101.042	75.654	4.579	27.542	2.213	60.458	2.011	0.387	3.490	13.721	13.675	33.723	18.353	39.105
5	39.051	96.538	79.103	4.105	27.872	2.324	66.874	2.078	0.462	2.907	13.443	16.501	39.305	17.164	37.219
6	40.833	101.833	69.767	5.633	39.233	1.993	67.4	1.982	0.137	2.915	9.83	13.922	34.183	16.217	102.34
7	35.949	95.205	45.391	4.026	21.882	2.584	55.472	2.062	0.438	3.115	14.661	14.471	37.351	16.974	35.988
8	35.810	95.333	34.278	3.952	17.762	1.990	35.629	2.171	0.461	3.609	15.557	10.662	37.096	17.339	23.065
9	40.472	101.167	103.167	5.114	30.90	2.177	77.344	2.012	0.412	2.821	11.850	13.666	36.314	15.524	33.951

cluster, pods per plant and high harvest index. Cluster IV had the highest mean values for oil (18.353), while cluster V for protein (39.305). The contribution of individual characters to the total divergence has been worked out in terms of number of times it appeared first. Plant height at maturity (cm) followed by number of pods per cluster, protein content and oil content contributed maximum towards genetic divergence. This was in agreement with those earlier reported by Bartual *et al.*, (1985).

In view of this it is suggested that for varietal development, the crosses between the genotypes of divergent clusters should be made rather than between the genotypes of those clusters which have the minimum divergence.

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Genetic Variability and Heritability for Physiological and Yield Attributes in Rice (*Oryza sativa* L.)

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ABSTRACT

Twenty one rice genotypes (6 parents and 15 F_1 crosses) were studied for variability, heritability, genetic advance and genetic advance as per cent of mean during *rabi* season of 1999-2000. The characters under consideration showed moderate to low PCV and GCV values. Leaf N per cent recorded the highest PCV and GCV values followed by number of grains per panicle and grain yield per plot, while, the lowest value was recorded by L/B ratio. The genetic advance as per cent of mean was the highest for leaf N per cent while the lowest for L/B ratio.

Key words : Rice Genotypes, Leaf N per cent, L/B ratio

The success of breeding programme depends upon the quantum of genetic variability available for exploitation and the extent to which the desirable characters are heritable. High heritability estimates were helpful in making selection of superior genotypes on the basis of phenotypic performance of quantitative characters. Johnson *et al.*, (1955) suggested that heritability and genetic advance when calculated together were more useful for predicting the resultant effect of selecting the best individuals than when, heritability and genetic advance are calculated alone. The present study was therefore, undertaken to determine the variability parameters among 21 rice genotypes.

MATERIAL AND METHODS

The experiment comprising 6 parents viz., ARC 5780, BPT 5204, BPT 1768, MTU 2067, NLR 33641 and BPT 4358. These 6 parents were crossed in diallele fashion resulting in 15 F_1 cross

combinations excluding reciprocals. The 15 F_1 should be together with 6 parents were sown in *rabi* 1999-2000 in a Randomised Block Design with 3 replications. Observations were recorded on five randomly chosen plants from the central row under each replication in hybrids and parents. Statistical analysis of the data was done according to Griffing (1956). The variability for yield and yield components was calculated according to the formula suggested by Burton (1952). Heritability and genetic advance ~~was~~ worked out as per Allard (1960).

RESULTS AND DISCUSSION

The results on mean performance revealed that among parents BPT 5204 and NLR 33641 recorded high mean values for grain yield, number of grains per panicle and number of productive tillers per hill, whereas BPT 1768 and MTU 2067 found to be superior for test weight and kernel weight. Among the hybrids BPT 5204 x NLR 33641 recorded high mean values for grain yield

Table - 1 Mean values of parents and hybrids for different characters in rice

	Number of Productive tillers/hill	Total chloro- phyll (%)	Test weight (g)	Grain yield per plot (kg)	Amylose content	Harvest index	Protein content (%)	No. of Grains per panicle	Leaf area index	Leaf nitrogen (%)	Volume expansion ratio	L/B ratio	Kernel weight (g)
ARC 5780	11.48	2.36	26.28	78.55	22.37	46.30	9.33	121.3	3.94	1.68	6.90	3.09	21.03
BPT 5204	13.31	3.15	18.52	109.60	23.18	50.00	8.83	172.3	4.07	2.24	6.50	3.54	14.82
BPT 1768	9.17	2.43	22.04	62.67	21.23	43.00	9.63	136.3	4.35	1.12	5.75	3.34	17.63
MTU 2067	11.47	2.92	22.06	97.05	22.10	44.00	8.17	154.7	3.94	1.93	4.88	3.23	17.65
NLR 33641	13.65	3.53	21.41	109.80	24.15	50.00	8.81	225.0	4.43	2.38	5.32	3.22	17.13
BPT 4358	11.57	3.61	21.36	78.28	23.37	46.00	8.82	169.0	4.14	1.12	6.27	3.25	17.09
Cross combinations													
ARC 5780 x 13.63	2.92	2.92	20.36	92.55	23.27	45.30	9.20	148.7	4.95	2.29	7.07	3.20	16.28
BPT 5204													
ARC 5780 x 11.25	2.69	2.69	25.14	82.69	22.87	45.00	9.54	141.7	4.12	1.37	7.09	3.36	20.12
BPT 1768													
ARC 5780 x 11.29	2.91	2.91	23.65	84.09	24.20	46.00	8.97	142.0	4.49	2.24	5.72	3.28	18.92
MTU 2067													
ARC 5780 x 13.33	3.60	3.60	24.65	101.85	23.07	49.70	9.34	163.0	4.14	1.59	6.99	3.20	19.72
NLR 33641													
ARC 5780 x 11.97	2.55	2.55	23.81	79.31	24.63	44.00	9.33	149.0	4.96	1.66	7.20	3.30	19.05
BPT 4358													
ARC 5204 x 13.77	3.25	3.25	22.02	101.53	23.83	51.00	8.96	177.7	4.36	2.01	6.61	3.59	17.62
BPT 1768													
BPT 5204 x 13.55	3.19	3.19	25.08	108.47	24.38	48.70	8.73	181.0	4.13	2.33	6.34	3.53	20.06
MTU 2067													
BPT 5204 x 13.97	3.55	3.55	25.38	111.53	25.17	53.00	8.83	198.0	4.47	2.33	6.01	3.49	20.30
NLR 33641													
BPT 5204 x 13.61	3.11	3.11	23.51	105.27	24.68	49.30	8.84	174.0	4.60	2.19	6.50	3.30	18.81
BPT 4358													
BPT 1768 x 9.65	2.64	2.64	24.91	79.55	22.60	46.30	9.21	150.0	4.47	1.40	5.74	3.40	19.93
MTU 2067													
BPT 1768 x 10.09	2.75	2.75	23.90	81.67	22.06	45.70	9.36	167.7	4.27	1.45	5.59	3.36	19.12
NLR 33641													
BPT 1768 x 10.24	2.63	2.63	21.37	70.01	23.57	45.30	9.27	163.7	4.82	1.45	5.88	3.35	17.09
BPT 4358													
MTU 2067 x 12.79	3.58	3.58	21.60	98.71	23.48	45.30	8.35	182.0	4.29	2.25	5.24	3.25	17.28
NLR 33641													
MTU 2067 x 11.95	3.01	3.01	26.02	93.48	23.87	43.30	8.30	166.3	4.07	1.87	5.41	3.29	20.82
BPT 4358													
NLR 33641 x 14.21	3.63	3.63	19.99	100.71	25.00	52.70	8.85	230.0	4.58	2.38	5.74	3.22	15.99
BPT 4358													
Mean	1218	3.05	23.00	91.78	23.45	47.14	8.98	167.30	4.36	1.87	6.13	3.32	18.40
SEm	0.298	0.247	0.276	1.98	0.395	1.145	0.112	4.02	0.133	0.121	0.143	0.057	0.222
CD	0.851	0.706	0.789	5.66	1.13	3.27	0.319	11.49	0.379	0.345	0.409	0.164	0.634
CV%	4.23	14.05	2.080	3.75	2.91	4.21	2.16	4.17	5.27	11.20	4.05	2.99	2.09

Table - 2 : Estimates of PCV, GCV, $h^2(b)$, GA and expected genetic advance as percent of mean of different characters in rice

Character	PCV (%)	GCV (%)	$h^2(b)$ (%)	GA	GA %
Number of productive tillers per hill	13.14	12.44	89.60	2.96	24.29
Total chlorophyll (%)	17.91	11.10	38.40	0.43	14.11
Test weight (g)	9.47	9.23	95.20	4.27	18.56
Grain yield per plot (kg)	15.85	15.40	94.40	28.29	30.82
Amylose content (%)	5.03	4.10	66.40	1.62	6.89
Harvest index (HI)	7.25	5.91	66.40	4.68	9.93
Protein content (%)	4.77	4.25	79.50	0.70	7.79
Number of grains per panicle	16.36	15.82	93.50	52.72	31.51
Leaf area index (LAI)	8.16	6.20	57.70	0.42	9.63
Leaf nitrogen (%)	24.95	22.29	79.90	0.77	41.15
Volume expansion ratio	11.64	10.92	87.90	1.29	21.04
L/B ratio	4.57	3.45	57.00	0.18	5.42
Kernel weight (g)	9.47	9.23	95.10	3.41	18.53

whereas NLR 33641 x BPT 4358 recorded high values for number of productive tillers and number of grains per panicle (Table 1).

Leaf N per cent recorded the highest PCV of 24.95, while L/B ratio recorded the lowest value of 4.57 per cent, whereas leaf N per cent recorded high GCV (22.29) while the lowest GCV was recorded by L/B ratio (3.45).

The heritability estimates indicates only the effectiveness with which selection of genotype can be based on the phenotypic performance but fail to indicate the real progress. Therefore, high heritability need not always accompanied by the genetic progress. Highest heritability was recorded by test weight (95.20) followed by kernel weight (95.10) and grain yield (94.40), while the lowest heritability was recorded by total chlorophyll (38.40). In spite of high heritability values for most of traits, estimates of genetic grain varied considerably.

Number of grains per panicle recorded the highest genetic advance (52.72) followed by grain

yield (28.29), while the lowest genetic advance was observed for L/B ratio (0.18). The genetic advance as per cent of mean was the highest for leaf nitrogen per cent (41.15) followed by number of grains per panicle (31.51) while the lowest value was observed for L/B ratio. Similar results of high h^2 and GA for number of grains per panicle were reported by Singh and Chaudhary (1996) and Mani *et al.*, (1997). Number of grains per panicle, number of productive tillers and grain yield recorded high h^2 coupled with high GA indicates the prevalence of additive gene action, whereas leaf N per cent recorded high heritability and low genetic advance indicates prevalence of non-additive gene action. This character can be improved by heterosis breeding.

In the present investigation number of grains per panicle, leaf N per cent and grain yield can be considered as the important characters to impart selection as they possessed high PCV, GCV coupled with high heritability and genetic advance.

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Genetic Variability and Character Association in Rice

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ABSTRACT

Genetic parameters like variability and correlations were estimated from 44 genotypes of rice for 9 quantitative characters viz., plant height, days to 50 % flowering, number of productive tillers per plant, panicle length, number of spikelets per panicle, number of filled grains per panicle, 100 grain weight, L/B ratio and grain yield per plant. The variance analysis revealed that the high genetic variability present in the quantitative characters studied. Grain yield per plant was positively and closely associated with plant height, days to 50% flowering, panicle length, total number of spikelets per panicle, number of filled grains per panicle and 100 grain weight. These characters were positive and highly associated among themselves.

Key words : Rice, Genetic Variability, Character Association

Rice offers a wealth of material for genetical studies because of its wide ecological distribution and enormous variation encountered for various morphological and physiological characters. Yield is a complex character governed by a large number of quantitative characters, which are especially important in plant breeding. Application of biometrical techniques in plant breeding in recent years has led to the great understanding of genetics of

quantitative characters and found to be extremely useful to the plant breeder for systematic genetic analysis and planning sound breeding programme. For this thorough knowledge of the nature and magnitude of genetic variability and association of characters in a group in a crop species is essential. Based on importance of the above aspects, an attempt had been made in rice for estimating genetic variability and character association for yield and its contributing characters.

Table - 1 Estimates of GCV, PCV, h^2 (b) and GA for 9 contributing characters in 44 genotypes of rice

S.No.	Character	Mean	GCV	PCV	h^2 (b)	GA
1.	Plant height	105.65	24.848	25.759	96.460	54.079
2.	Days to 50% flowering	110.11	8.334	8.488	98.191	18.905
3.	Productive tillers per plant	9.72	8.268	71.239	11.607	1.656
4.	Panicle length	22.22	9.629	10.881	88.494	4.407
5.	Number of spikelets per panicle	134.75	21.997	23.468	93.735	61.062
6.	Filled grains per panicle	107.31	20.386	23.877	85.378	45.066
7.	100 - Grain weight	2.05	18.393	19.397	94.822	0.780
8.	L/B ratio	2.95	8.956	9.756	91.800	0.545
9.	Grain yield per plant	19.27	21.163	27.825	76.057	8.401

MATERIAL AND METHODS

The study was carried out with 44 phenotypically diverse genotypes of rice obtained from different sources. The experiment was conducted at the Agricultural college farm, Bapatla, Andhra Pradesh. The experiment was conducted in a randomised block design with three replications. Each genotype was planted in 3 rows and each row of 3m length with a spacing of 20 cm apart between rows and 15 cm with in the row (60 hills per plot). The crop was fertilised at the rate of 80 Kg N, 40 Kg P₂O₅ and 30 Kg K₂O per ha. Half of the nitrogen and entire P₂O₅ and K₂O was applied as basal dressing. The remaining nitrogen was applied in equal split doses, one at 30 days after planting and the remaining dose at 60 days after planting. Observations were recorded on 9 characters viz., plant height (cm), days to 50% flowering, number of productive tillers per plant, panicle length (cm), number of spikelets per panicle, number of filled grains per panicle, 100 grains weight (g), grain length and breadth (mm) and grain yield per plant (g). Single plant observations were recorded on 10 plants chosen at random in each plot leaving border rows and their means were used for statistical analysis.

RESULTS AND DISCUSSION

Studies on variation and genetic parameters revealed that all the traits exhibited significant genetic variability, high GCV and high genetic advance (Table 1.) suggested that selection for these characters may be effective. Similarly high heritability, high GCV and moderate GA for panicle length, 100 grain weight, days to 50% flowering and L/B ratio indicated that improvement of these characters is also possible, whereas remaining traits are unsuitable for improvement by direct selection alone. The narrow range of difference between PCV and

Table - 2 Estimation of phenotypic and genotypic correlation coefficients between yield and yield components obtained from 44 genotypes of rice

Character	Plant height	Days to 50 % flowering	Productive tillers/plant	Panicle length(cm)	Total spikelets/panicle	Filled grains/panicle	100- Grain weight (g)	L/B ratio	Correlation with Grain yield
Plant height	1.0000	-0.2942 (-0.3065)	0.0556 (0.2495)	0.6002* (0.648)*	-0.4045* (-0.4754)*	-0.3006 (-0.4134)*	0.6720* (0.7322)	-0.7040 (-0.0740)	0.2592 (0.3430)
Days to 50% flowering		1.0000	-0.1256 (-0.4012)*	-0.4220* (-0.4789)*	0.3585* (0.3989)*	0.3291* (0.3952)*	-0.2107 (-0.2229)	0.0739 (0.0851)	0.0092 (0.0142)
Productive tillers			1.0000	0.0336 (0.1226)	-0.1413 (-0.7429)	-0.1184 (-0.6310)	0.0938 (0.3280)	0.0182 (0.1699)	0.2333* (0.5558)
Panicle length				1.0000	0.0966 (-0.1963)	-0.0399 (-0.1816)	0.5446* (0.6225)*	0.0794 (0.1059)	0.2241 (0.2920)
Total spikelets/panicle					1.0000	0.8868* (0.9496)*	-0.5252* (-0.5894)*	0.1536 (0.1953)	0.3623* (0.3248)
Filled grains/panicle						1.0000	-0.4384* (-0.5213)*	0.0883 (0.1436)	0.3557* (0.3658)
100 - Grain weight								-0.1439 (-0.1683)	0.2401 (0.2548)
L/B ratio								1.0000	0.1057 (0.1734)
Grain yield									1.0000

* Significant at P = 0.05

Figures in paranthesis are genotypic correlation coefficients

GCV in traits like plant height, days to 50% flowering, panicle length, number of spikelets per panicle, filled grains per panicle, 100 grains weight and L/B ratio. These are in accordance with the findings of Mayura *et al.*, (1986), Reddy *et al.*, (1988), Pathak and Patel (1989) and Srinivasa Rao (1989) in rice.

Character association studies will be highly useful to know the suitability of various characters for selection. Direct selection for yield may be ineffective, because yield is a complex entity and is quantitatively inherited with low heritability. Therefore the character association studies yield and yield components is important in selection programme. Characters viz., number of productive tillers per plant, total number of spikelets per panicle, number of filled grains per panicle had significant positive association with grain yield per plant indicated that these characters had direct influence on yield.

Panicle length, 100 grain weight, L/B ratio and plant height had positive correlation with yield but they are non significant (Table 2.). The estimates of PCV were higher than GCV indicating an inherent association between the characters. Panicle length had positive association with total spikelets/panicle, L/B ratio, while positive and significant association with 100 grain weight. 100 grain weight had positive significant correlation with panicle length and plant height.

Other significant positive correlations recorded were plant height with panicle length and 100 grain weight and total spikelets with filled grains per panicle. These findings clearly indicated that productive tillers per plant, number of spikelets per panicle, number of filled grains

per panicle, panicle length and 100 grain weight were the most important traits to improve the yield in rice. These findings are in accordance with Venkateswarlu *et al* (1973), Bhattacharya (1981) and Reddy and Reddy(1981).

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Genetic Divergence in Sunflower (*Helianthus annuus* L.)

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ABSTRACT

Sunflower genotypes consisting of 52 inbreds revealed considerable amount of variability for all characters under study. High heritability and high genetic advance as per cent of mean was obtained for all the characters except for days to 50% flowering and days to maturity which indicate additive genetic variance that would respond more to simple selection procedures. The results of Mahalanobis's D^2 analysis indicated that the genotypes were grouped into seven clusters and crosses can be made between the genotypes of cluster II and cluster VII, cluster VI and cluster V to create more variability in sunflower.

Key words : Genetic variability, genetic divergence, Sunflower.

Sunflower has a great potential in bridging the gap between demand and supply of edible oil to a significant extent in the years to come. Information on variability and heritability of seed yield is essential for crop improvement. The choice of suitable parents is of paramount importance for a planned hybridization programme. Hence it is imperative to identify the best parents with wide genetic divergence for characters of economic importance, so that they can be utilized in breeding programmes to produce desirable recombinants.

MATERIAL AND METHODS

The present investigation was carried out during *rabi*, 2002-2003 at the Agricultural college farm, Bapatla. The experiment was conducted in a randomized block design with three replications using 52 genotypes (inbreds) of sunflower. Each genotype was sown in three rows of 4.5m length with a spacing of 45x30 cm. Recommended agronomic practices were followed to raise a good crop. Observations on five randomly selected plants per plot were

recorded for yield attributing characters such as; days to 50% flowering, plant height, stem diameter, number of leaves per plant, days to maturity, head diameter, number of filled seed per head, 100-seed weight, total dry matter production per plant, seed yield per plant, oil content and harvest index. Phenotypic and genotypic coefficients of variation (PCV and GCV) were computed as per the formula given by Burton (1952), heritability and genetic advance as suggested by Allard (1960) and Johnson *et al.* (1955) and genetic divergence by Mahalanobis D^2 analysis (1936).

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences among 52 genotypes for all the characters under study, thus indicating the existence of high variability for different characters studied. High PCV and GCV values (Table 1) were observed for number of filled seed per head, 100-seed weight, total dry matter production per plant, harvest index and seed yield per plant. High heritability with high genetic

Table 1 : Estimates of variability and genetic parameters for seed yield and yield attributes in sunflower

S.No.	Character	Mean	PCV	Coefficient of Variation(%)		GA	GAM
				GCV	h^2 (b)		
1.	Days to 50% flowering	57.44	5.26	5.05	92.21	5.74	10.00
2.	Plant height (cm)	145.136	14.98	14.58	94.74	42.45	29.24
3.	Stem diameter (cm)	1.60	19.97	19.61	96.47	0.63	39.69
4.	Leaves/plant	24.73	16.96	16.62	96.03	8.30	33.56
5.	Days to maturity	88.32	3.77	3.67	94.81	6.51	7.37
6.	Head diameter (cm)	11.39	16.75	16.33	94.96	3.73	32.78
7.	Filled seed / head	479.90	39.64	39.12	97.41	381.76	79.55
8.	100 Seed weight (g)	4.14	29.42	29.20	98.46	2.47	59.68
9.	TDMP / plant (g)	110.58	23.32	23.04	97.61	51.86	46.89
10.	Seed yield / plant (g)	20.26	56.50	56.18	98.86	23.32	115.07
11.	Oil content (%)	29.36	14.92	14.50	94.42	8.52	29.03
12.	Harvest index(%)	17.81	40.00	39.54	97.74	14.34	80.54

GCV = Genotypic coefficient of variation.

PCV = Phenotypic coefficient of variation

$h^2(b)$ = Heritability in broad sense

GA = Genetic advance

GAM = Genetic advance as per cent of mean

TDMP = Total dry matter production

Table 2 : Distribution of 52 genotypes of sunflower in different clusters

Cluster No.	No. of Genotypes	Genotypes
I	10	DSI - 141, DSI - 169, DSI -9, DSI - 148, DSI - 167, DSI - 112, DSI - 149, DSI -171, DSI - 29, DSI - 150
II	2	DSI -151, DSI - 172
III	11	DSI - 142, DSI - 162, CMS 335B, DSI - 158, DSI -82, DSI - 19, DSI -137, CMS 353B, DSI -145, DSI -155, DSI -159
IV	7	DSI - 143, DSI - 173, DSI -161, DSI - 144, DSI - 174, DSI -139, BLC - P6
V	3	DSI - 175, CMS 851B, DSI - 138
VI	7	DRS -2, DRM 65-4, DSI - 69, SF 216, DSI - 166, DRM 10-2 SF-206
VII	12	DSI - 152, DSI - 168, DSI - 216, DSI - 163, DSI - 147, DSI - 156, DSI - 203, DSI - 201, SF 208, DSI - 209, DSI - 204, DSI - 212

advance as per cent of mean was obtained for all the traits except for days to maturity and days to 50% flowering indicating additive gene action controlling these traits which can be improved by simple selection. Teklewold *et al.* (1999), Ravi (2001) and Subrahmanyam *et al.* (2002) reported similar results.

The genetic divergence was estimated by using Mahalanobis D^2 Statistic. The magnitude of D^2 values indicated considerable variability in the available germplasm. The genotypes were grouped into seven clusters (table 2). The maximum inter cluster distance was recorded between cluster II and VII, while the least inter

Table 3 : Intra and inter cluster average divergence (D and D²) values of seven clusters from 52 genotypes of sunflower

	I Cluster	II Cluster	III Cluster	IV Cluster	V Cluster	VI Cluster	VII Cluster
I Cluster	10.34 (106.97)	19.15 (366.95)	18.85 (355.62)	14.00 (196.00)	16.52 (273.00)	18.35 (336.97)	25.85 (668.27)
II Cluster		19.28 (371.79)	29.28 (857.72)	26.39 (696.90)	29.29 (899.70)	31.38 (985.14)	39.21 (1537.81)
III Cluster			11.90 (141.72)	13.40 (179.72)	16.25 (264.19)	14.84 (220.46)	15.64 (245.04)
IV Cluster				9.05 (81.99)	13.66 (186.75)	13.17 (173.52)	17.81 (317.44)
V Cluster					10.10 (102.17)	14.49 (210.01)	17.34 (300.84)
VI Cluster						10.25 (105.08)	14.57 (212.43)
VII Cluster							9.09 (82.77)

Figures in bold indicate Intra cluster distances

Figures in parenthesis are D² values

cluster distance was recorded between IV and VI. Maximum intra cluster distance was observed in the cluster II while the least intra cluster distance (D value) was observed in cluster IV (Table 3). Based on inter cluster distance, cluster II had more genetic divergence with VII, VI and V which upon hybridization are likely to produce desirable recombinants.

According to Arunachalam (1981), parents chosen to be genetically divergent through D² analysis can fail, at times to show high gene frequency differences, a major reason why heterosis fails to result on hybridization. Manjula *et al.*, (2001) stated that, while choosing genotypes as parents for hybridization, the *per se* performance of genotypes with high D² value should be taken into consideration in addition to maximum inter-cluster distance among the genotypes.

The mean performance of clusters (Table 4) indicated that cluster II consisting of two genotypes had highest mean values for desirable characters like; head diameter, stem diameter, number of filled seed per head, 100-seed weight, harvest index and seed yield per plant and it had lowest mean value for days to 50% flowering. One of the genotypes (DSI-172) of this cluster had undesirable traits like late maturity and high plant height, whereas the other genotype (DSI-151) is early in maturity with medium plant height. These genotypes could be considered as important sources for improvement of most of the traits. The genotypes of cluster VII showed poor performance for yield and most of the yield components. So, their importance to serve as parents for breeding work seems to be limited. Cluster VI consisted of genotypes having short plant height, early in maturity but lowest in number of leaves per plant. Maximum number

Table 4 : Mean values of seven clusters from 52 genotypes of sunflower for 12 characters

	Days to 50% flowering	Plant height (cm)	Stem diameter (cm)	Leaves per plant	Days to maturity	Head diameter (cm)	Filled seed per head	100-seed weight (g)	TDMP per plant (g)	Seed yield per plant (g)	Oil content (%)	Harvest index (%)
I Cluster	57.16	160.34	2.02	25.29	88.00	12.19	709.80	4.89	138.83	34.17	33.55	25.50
II Cluster	55.66	161.00	2.36	27.65	89.00	13.49	722.68	7.25	144.63	51.69	29.51	36.88
III Cluster	56.81	150.35	1.47	24.76	87.90	11.77	342.65	4.76	111.96	15.59	27.47	14.11
IV Cluster	61.57	152.52	1.66	23.49	92.76	12.27	520.97	4.33	121.04	21.85	31.18	18.84
V Cluster	56.44	153.18	1.61	33.82	86.88	11.07	599.68	3.49	124.62	20.84	32.47	17.73
VI Cluster	56.33	110.84	1.54	20.31	86.57	10.94	541.24	3.40	92.57	18.07	28.49	19.93
VII Cluster	57.02	138.71	1.24	24.78	87.66	9.87	283.99	2.89	80.98	7.93	26.24	9.92
TDMP. Total dry matter production												

Table 5 : Contribution of different traits to the genetic divergence (D^2) in 52 genotypes of sunflower

S.No.	Character	Times ranked first	% Contribution to the / divergence	Rank
1	Days to 50% flowering	26	1.96%	11
2	Plant height (cm)	49	3.70%	9
3	Stem diameter (cm)	0	0.00%	12
4	Leaves/plant	108	8.14%	4
5	Days to maturity	63	4.75%	8
6	Head diameter(cm)	64	4.83%	7
7	Filled seed/head	46	3.47%	10
8	100 seed weight(g)	248	18.70%	2
9	TDMP/ plant (g)	238	17.95%	3
10	Seed yield/plant(g)	331	24.96%	1
11	Oil content (%)	87	6.56%	5
12	Harvest Index (%)	66	4.98%	6

of leaves per plant was exhibited by cluster V. Cluster I showed highest mean value for oil content.

By taking inter cluster distance and *per se* performance of genotypes into consideration, the following crosses may be recommended for desirable recombinations for seed yield and yield components. Crosses involving genotypes of cluster II (DSI-151 and DSI-172) with cluster VII (DSI-147, DSI-168), cluster VI (DRM10-2, DSI-166) and cluster V (DSI-175) may result in heterosis.

The percentage contribution of each trait towards genetic divergence varied between 24.96 to zero. Seed yield per plant (24.96%) contributed maximum towards genetic divergence followed by 100-seed weight (18.70%) and zero per cent contribution by stem diameter (Table 5). Muppithathi *et al.* (1995) and Ravi (2001) reported that seed yield per plant contributed maximum towards genetic divergence, which is in agreement with the present finding.

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Character Association and Path Analysis for Seed Yield and Yield Attributing Characters in Sesame (*Sesamum indicum* L.)

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ABSTRACT

Correlation studies involving four lines, three testers and twelve hybrids obtained by line x tester mating design of sesame indicated that number of capsules per plant, number of seeds per capsule, number of primaries, 1000-seed weight and plant height were significant and positively associated with seed yield per plant, number of capsules per plant, 1000-seed weight, days to maturity, oil content and plant height had positive direct the path analysis revealed that number of seeds per capsule, effect on seed yield per plant and can be considered as important selection criteria for yield improvement..

Key words : Sesame, Correlation, Path analysis.

For the selection of genotypes in sesame for seed yield improvement, it is necessary to understand the association of different component characters with seed yield as well as among themselves. However, direct selection based on correlations may not be effective, when there are many characters influencing one another. It is necessary to split the total correlation coefficient in to direct and indirect effects on a given character. Correlation in combination with path coefficient analysis gives a better insight into cause and effect relationship between different pairs of characters.

MATERIAL AND METHODS

Four lines and three testers were crossed in line x tester mating design to obtain twelve hybrids. These twelve hybrids along with their parents were studied during *rabi* 2002-03 at Agricultural College Farm, Bapatla. The design followed was randomised block design with a spacing of 30 x 10 cm. Ten plants at random

from each treatment were selected for recording observations on various traits as listed in Table 1 and mean values of these ten plants were used for statistical analysis. Correlation (Falconer, 1964) and path analysis (Dewey and Lu; 1957) were worked out.

RESULTS AND DISCUSSION

The estimated phenotypic and genotypic correlations of different characters were presented in Table 1. In general, the genotypic correlation coefficients were higher than the phenotypic coefficients indicating the masking effect of the environment in the total expression of the genotypes. Similar results were reported by Thangavelu and Rajasekaran (1983). Seed yield per plant was significantly and positively correlated with number of capsules per plant, number of seeds per capsule, number of primaries, 1000-seed weight and plant height. Similar results were reported by Ramireddy and Sundaram (2002).

Table - 1 Phenotypic and genotypic correlation coefficients among yield and yield components in parents and hybrids of Sesamum

Character	Days to 50% flowering	Plant height	Days to maturity	No. of primaries	No. of capsules per plant	No. of seeds per capsule	1000-seed weight	Oil content	Seed yield per plant
Days to 50% flowering	---	-0.001 (-0.001)	0.386 (0.421)	-0.093 (-0.098)	0.204 (0.208)	0.011 (0.008)	0.042 (0.043)	0.027 (0.033)	0.110 (0.111)
plant height		---	0.113 (0.127)	0.526* (0.540)*	0.350 (0.358)	0.374 (0.380)	0.080 (0.086)	0.246 (0.266)	0.466* (0.467)*
Days to maturity			---	-0.280 (-0.305)	-0.186 (-0.215)	0.146 (0.167)	-0.237 (-0.257)	0.087 (0.086)	-0.013 (-0.014)
No. of primaries				---	0.519* (0.539)*	0.160 (0.156)	0.506* (0.524)*	0.087 (0.106)	0.524* (0.532)*
No. of Capsules per plant					---	0.256 (0.262)	0.506* (0.551)*	0.257 (0.282)	0.805** (0.825)**
No. of seeds per capsule						---	-0.228 (-0.233)	0.300 (0.317)	0.651** (0.656)**
1000-seed weight							---	0.078 (0.091)	0.493* (0.511)*
Oil content								---	0.397 (0.424)
Seed yield per plant									---

* Significant at 5% level

** Significant at 1% level.

Figures in parenthesis indicate genotypic correlation.

Table - 2 Path coefficients of yield and yield components in parents and hybrids of sesamum.

Character	Days to 50% flowering	Plant height	Days to maturity	No. of primaries	No. of capsules per plant	No. of seeds per capsule	1000-seed weight	Oil content	Correlation coefficients with yield per plant
Days to 50% flowering	-0.0417	-0.0001	0.0323	0.0029	0.0903	0.0069	0.0186	0.0016	0.1108
plant height	0.0001	0.0455	0.0095	-0.0162	0.1553	0.2234	0.0351	0.0139	0.4665*
Days to maturity	-0.0161	0.0052	0.0836	0.0086	-0.0827	0.0871	-0.1033	0.0045	-0.0132
No. of primaries	0.0039	0.0240	-0.0235	-0.0307	0.2300	0.0954	0.2204	0.0049	0.5243*
No. of Capsules per plant	-0.0085	0.0160	-0.0156	-0.0159	0.4430	0.1526	0.2200	0.0145	0.8059**
No. of seeds per capsule	-0.0005	0.0171	0.0122	-0.0049	0.1134	0.5960	-0.0991	0.0169	0.6510**
1000-seed weight	-0.0018	0.0037	-0.0199	-0.0156	0.2242	-0.1359	0.4347	0.0044	0.4939*
Oil content%	-0.0012	0.0112	0.0067	-0.0027	0.1139	0.1788	0.0342	0.0563	0.3973

Figures underlined indicate direct effects.

(Residual effect = 0.1362)

Number of primaries showed significant positive correlation with plant height, number of capsules per plant and 1000-seed weight. Number of capsules per plant was also correlated positively and significantly with 1000-seed weight. Characters days to 50% flowering and oil content were non-significant but positively associated with seed yield per plant, whereas days to maturity recorded negative, non-significant association with seed yield per plant.

The estimates of correlation coefficients mostly indicated the interrelationship of different characters but do not furnish information on cause and effect. Under such a situation path analysis helps the breeder in identifying the ideal index of selection. The results of path coefficients based on correlation coefficients are furnished in Table 2. The maximum direct effect on seed yield was exerted by number of seeds per capsule (0.5960). The indirect effects of other characters *via* seed yield was considerable, indicating the importance of number of seeds per capsule in the selection programme. Positive direct effect of number of seeds per capsule on seed yield was reported by Tomar *et al.* (1999). Other characters *viz.*, number of capsules per plant (0.4430), 1000-seed weight (0.4347), days to maturity (0.0836), oil content (0.0563) and plant height (0.0455) exhibited positive direct effects on seed yield per plant. The low positive residual effect (0.1362) indicated that most of the important seed yield contributing characters have been included in the present study.

It may be concluded that number of capsules per plant, number of seeds per capsule, 1000-seed weight and plant height are the most important characters to be considered for development of high seed yielding genotypes in sesame.

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Heterosis for Yield and Yield Components in Pigeonpea (*Cajanus cajan* (L.) Mill sp.)

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ABSTRACT

Line x tester analysis using 18 hybrids involving 3 lines and 6 testers was carried out to study heterosis over better parent (BP) and standard check (SC) for 11 characters. Only four cross combinations manifested significant positive standard heterosis involving at least one parent with high yield potential. Significant and high degree of useful heterosis was observed in number of branches per plant, protein content, pod length and number of pods per plant. Regarding heterobeltiosis for seed yield, Bhadbhoot x BP 87-58 manifested significant positive high heterotic effect. High response for seed yield per plant was attributed to pod length, number of branches per plant and number of pods per plant.

Key words : Line x tester, Heterosis, Pigeonpea

Exploitation of heterosis appears to be a cheap and easy method for increasing yield in many crops. Pigeonpea being an often cross-pollinated crop, the possibility of exploiting its hybrid vigour depends upon the direction and magnitude of heterosis and the type of gene action involved. Cross combinations showing hybrid vigour can be used for developing high yielding purelines. The present investigation was done to collect information on heterosis for yield and its components in pigeonpea.

MATERIAL AND METHODS

Three genetically diverse pigeonpea lines viz., GT 1, Bhadbhoot and T 15-15 were crossed with six testers viz., BP 90-61, BP 87-58, BP 94-01, BP90-48, GAUT 86-25 and GAUT 95-3 in a line x testers mating design. Eighteen hybrids along with three lines, six testers and one check (ICPL 87119) were sown in a randomized block design with three replications at Pulses Research Station, Gujarat Agricultural University, Navsari during *Pre-Rabi-2000* and recommended package of practices were followed. Five plants randomly

selected from each row per replication were used for recording the data on eleven traits. Heterosis over better parent (heterobeltiosis) and over standard check were calculated and test of significance was done as per Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed highly significant differences among parents and crosses for most of the characters studied, indicating the presence of sufficient amount of genetic variability in the material used.

Componentwise examination of all 18 F₁s, only four exhibited significant positive heterosis over standard check (ICPL 87119) (Table 2) ranging from -17.39 to 45.62 per cent, 7.08 to 55.84 per cent, -15.51 to 48.16 per cent, -22.72 to 13.11 per cent for seed yield per plant, number of branches per plant, number of pods per plant and pod length, respectively. These crosses are Bhadbhoot x BP 87-58, GT 1 x GAUT 86-25, Bhadbhoot x BP 94-01 and GT 1 x BP 94-01.

Table - 1 : Analysis of variance (mean squares) for different characters in pigeonpea

Source of variation	d.f.	Seed yield per plant (g)	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	Pod length (cm)	Number of seeds per pod	100-seed weight (g)	Protein content (%)	Harvest index
Replication	2	28.91	20.81	12.60	146.54	2.79	623.28	0.99	1.18	0.91	0.04	19.82
Parents	8	271.16*	81.76**	41.56**	349.38**	3.74**	1938.04**	1.17**	0.28*	0.81	12.07**	250.73**
Lines	2	395.62*	87.11**	20.33**	507.00	5.85**	4279.69**	2.61**	0.69**	0.16	12.05**	31.44**
Testers	5	181.49*	95.02**	50.19**	233.05	3.64**	1167.69**	0.53**	0.10	1.23**	13.60**	84.52**
Lines vs testers	1	470.58**	4.74	40.91**	615.77**	0.01	1107.31*	1.47**	0.34**	0.003	4.45**	73.50**
Crosses	17	561.98**	78.76**	56.27**	206.61**	3.28	1744.05**	0.15**	0.32**	1.14**	10.82**	29.31**
Parents vs crosses	1	1687.68**	180.50**	35.65**	6050.00**	44.18**	9780.41**	0.98**	0.01	0.27	5.08**	142.45**
Error	52	165.36	5.20	4.61	147.04	1.19	447.41	0.03	0.11	0.22	0.44	10.36
S.E.m±		7.42	1.32	1.16	7.00	0.63	12.21	0.01	0.19	0.27	0.38	1.61

* Significant at 5 per cent

** Significant at 1 per cent

Regarding 100-seed weight and protein content, the magnitude of standard heterosis ranged from -16.71 to 6.77 per cent and -11.61 to 15.96 per cent, respectively. Similar findings have been reported by Aghav *et al.* (1997) and Narladkar and Khapre (1996).

The magnitude of heterosis over the better parent (Table 3) manifested significant heterosis ranging from 17.41 to 43.16 for seed yield per plant, -10.84 to 31.69 per cent for number of branches per plant, -24.52 to 51.57 per cent for number of pods per plant, -25.08 to 12.65 per cent for pod length, -13.10 to 10.77 per cent for 100-seed weight, -16.52 to 16.58 per cent for protein content and -35.24 to 22.36 per cent for harvest index. Similar findings have been reported by Aghav *et al.* (1998) and Hooda *et al.* (1999).

Regarding days to 50 per cent flowering, days to maturity and plant height none of the hybrids depicted significant positive desirable heterotic effect either over standard check or over better parent.

It is evident from the result that only some components of yield were important for the expression of final product yield. In the selection programme, however, compromise to the desired level of each component may have to be made in order to obtain maximum yield because the component traits compete for the same total amount of metabolic substrates produced by the plant and the conditions, thereby the development of one component could have an adverse effect on other. It is further revealed that four crosses which exhibited high heterotic effects over standard check for seed yield per plant involved at least one parent having high yield potential which indicates possibility of obtaining new recombinations in segregating generations having high yield performance. Heterotic response for seed yield per plant was due to high heterotic response observed for pod length,

Table - 2 : Estimates of heterosis over standard check in pigeonpea

Crosses	Seed yield per plant (g)	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	Pod length (cm)	No. of seeds per pod	100-seed weight	Protein content (%)	Harvest index
GT 1x BP 90-61	-10.31	2.81	2.14	29.93**	19.59	-5.66	29.93**	-6.04*	-1.85	-1.64*	-15.83**
GT 1x BP 87-58	11.30	15.78**	7.95**	31.80**	33.05**	28.40	31.80**	-10.51**	-2.50	10.44**	-18.53**
GT 1x BP 90-48	-32.28	14.03**	6.23**	34.31**	7.08	-15.51*	34.31**	-16.45**	-6.22	15.96**	-12.84**
GT 1x BP 94-01	30.24*	8.76**	8.81**	35.65**	35.41**	19.83	35.65**	0	4.64**	8.85**	-31.73**
GT 1x GAUT 95-3	2.30	12.63**	8.17**	35.71**	16.52	11.85	35.71**	-6.71*	-4.64	11.27**	-20.03**
GT 1x GAUT 86-25	39.56**	11.23**	4.08*	39.90**	36.12**	42.74**	39.90**	-12.08**	6.77**	8.51*	-13.91**
Bhadbhoot x BP 90-61	-15.9	2.81	3.22	22.55**	55.84**	-2.84	22.55**	-10.51**	-6.22	-10.64**	-4.05**
Bhadbhoot x BP 87-58	45.62**	5.61**	6.23**	25.48*	48.76**	36.32**	25.48*	4.47**	-0.64	-8.70*	-8.06
Bhadbhoot x BP 90-48	-13.06	7.71**	4.51	20.68*	29.87**	11.81	20.68*	-14.98**	-10.58*	-7.25*	-12.15**
Bhadbhoot x BP 94-01	32.10**	13.33**	6.66**	21.17*	40.14**	33.08*	21.17*	0	-2.78	-7.11*	-45.67**
Bhadbhoot x GAUT 95-3	28.66	10.87**	7.09**	28.24**	36.12**	37.33**	28.24**	-3.13	-8.07*	4.01**	-11.85**
Bhadbhoot x GAUT 86-25	12.58	3.15	-0.64	26.90**	25.97*	25.34*	26.90**	-13.42**	-0.37	11.90**	2.67**
T 15-15 x BP 90-61	-8.02	15.78**	5.80**	29.84**	28.33**	9.57	29.84**	14.98**	-2.78	-11.61**	-8.62**
T 15-15 x BP 87-58	-0.016	18.6**	8.38**	34.33**	41.67**	31.43*	34.33**	-19.46**	-7.42*	9.96**	-13.88**
T 15-15 x BP 90-48	-3.13	3.86*	0.43	19.83*	23.61*	15.52	19.83*	-3.13	-16.71**	-11.12**	-44.41**
T 15-15 x BP 94-01	14.14	14.73**	6.23**	29.17**	44.86**	29.72*	29.17**	-14.98**	0.92	4.49**	-10.12**
T 15-15 x GAUT 95-3	-17.39	17.18**	6.45	27.11**	40.14**	13.37	27.17**	-22.37**	-7.14*	4.35**	-12.44**
T 15-15 x GAUT 86-25	22.46	16.49**	8.81**	29.11**	47.22**	48.16**	29.11**	-8.94**	-11.51**	1.45**	-8.52
S.Ed.±	10.49	1.86	1.75	9.90	0.89	17.27	9.90	0.27	0.38	0.54	2.62
C.D. at 5%	20.56	3.64	3.43	19.40	1.74	33.84	19.40	0.52	0.74	1.05	5.13
C.D. at 1%	27.06	4.79	4.51	25.54	2.29	44.55	25.54	0.69	0.98	1.39	6.75

* Significant at 5 per cent

** Significant at 1 per cent

Table - 3 : Estimates of heterobeltiosis in pigeonpea.

Crosses	Seed yield per plant (g)	Days to 50 per cent flowering	Days to maturity cent	Plant height (cm)	No. of branches per plant	No. of pods per plant	Pod length (cm)	No. of seeds per pod	100-seed weight	Protein content (%)	Harvest index
GT 1x BP 90-61	-3.31	1.03	-0.63	8.03*	17.83	-1.47	-1.12	-4.55	-1.28	-8.55	-5.31
GT 1x BP 87-58	34.56	13.79**	2.87**	15.20*	9.74	48.90**	-5.13*	-9.09	-6.03	1.03	-9.68
GT 1x BP 90-48	-22.87	12.85**	1.23	4.92	0.00	-22.15	-21.47**	-15.15**	-5.66	7.80**	13.22*
GT 1x BP 94-01	12.93	6.98**	6.98**	12.24*	5.85	-2.54	3.69	1.52	5.23	-0.30	-7.32
GT 1x GAUT 95-3	9.29	10.69**	6.57**	14.06*	-10.84	4.52	-4.70	-5.30	4.14	3.45	-27.3**
GT 1x GAUT 86-25	28.50	9.31**	-0.82	26.48**	30.08**	17.35	-21.50**	-10.61	4.83	-1.46	-14.98*
Bhadbhoot x BP 90-61	-17.41	-2.98	0.42	9.76	16.47*	-24.52*	-14.57**	-7.69	-3.47	-3.32	14.31
Bhadbhoot x BP 87-58	43.16*	-0.33	1.44	12.39*	11.18	5.61	2.80	14.75*	-4.21	-16.52**	18.78
Bhadbhoot x BP 90-48	-14.53	6.60**	-0.21	8.09	-2.94	-13.13	9.29**	-5.00	-6.71	-4.64	4.68
Bhadbhoot x BP 94-01	14.54	6.95**	4.86**	8.53	4.71	3.39	1.83	7.20	-1.23	-14.92**	-35.24
Bhadbhoot x GAUT 95-3	26.49	4.69*	5.51**	14.86*	1.76	6.69	-7.40**	3.17	-4.10	12.97**	2.89
Bhadbhoot x GAUT 86-25	3.66	-0.34	-5.13**	14.74*	-5.88	-2.62	12.65**	1.75	-2.22	1.61	22.36**
T 15-15 x BP 90-61	-0.84	8.20**	2.93**	26.15**	14.79	14.46	-3.35	-12.31	-0.06	-3.18	-3.59
T 15-15 x BP 87-58	20.88	4.97**	0.60	30.51**	16.88	51.57**	-15.94**	-11.48	10.77**	0.59	2.50
T 15-15 x BP 90-48	9.60	2.78	-4.69**	16.42*	10.56	6.46	8.74**	8.33	-12.94**	-8.62**	-16.59*
T 15-15 x BP 94-01	-0.03	6.17**	4.44*	25.48**	13.23	5.51	-0.50	8.80	2.55	-4.28	-1.11
T 15-15 x GAUT 95-3	-11.76	7.40**	4.87**	23.55**	7.23	5.94	-25.08**	-17.46**	-2.91	16.58**	1.67
T 15-15 x GAUT 86-25	12.76	12.54**	3.69**	25.43**	31.69**	21.80*	6.33*	7.02	-13.10**	-7.91	-19.60**
S.E.d.	10.49	1.86	1.64	9.90	0.89	17.27	0.15	0.26	0.38	0.54	2.28
C.D. at 5%	21.07	3.73	3.28	19.86	1.78	34.65	0.30	0.53	0.76	1.08	4.52
C.D. at 1%	28.09	4.98	4.37	26.49	2.58	43.28	0.40	0.70	1.02	1.45	5.98

* Significant at 5 per cent

** Significant at 1 per cent

number of branches per plant and number of pods per plant. Thus, selection of hybrids should be based on their heterotic effects.

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Character Association of Seeds on Plant Morphology in Snake Gourd (*Trichosanthes anguina* L.)

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ABSTRACT

Twenty five accessions of snake gourd were studied for various morphological characters for two years. The analysis of variance showed that significant difference between the accessions for all the characters studied except seed thickness. TA 111, TA 95 and CO-2 which were having dented pubescence with more number of female flowers. Seed size index value was maximum for TA 115 but it has minimum fruits per plant (seven) and yield (2.81 kg). It was possible to identify the cultivars on the basis of seed characters (Seed width, seed thickness and seed coat colour) and plant characters (pubescence and tendril length). A list of keys to identify varieties is presented.

Key words : Snake Gourd, Plant Morphology, Character Association, Seeds

Morphological marker characters have been invariably used by plant breeders to group the varieties. Characterisation of such cultivars is helpful in maintaining their genetic purity during seed production. Several workers have used plant and seed characters for distinguishing varieties of different crops (Ghosh and Dutta, 1975, Gill and Cubero, 1993). Measurements of seeds, along with other characters, were utilized in describing the *Poa pratensis* cultivars (Wiseman and Koszykowski, 1979). A list of key characters useful in varietal identification were prepared by studying morphological characters of six vegetable pea cultivars (Surendra Prakash and Singal, 1997). Twenty three inbred lines of maize were characterized based on the seed characters (Nagapadma *et al.*, 1996). Different morphological characters were used related to stem, leaf, flower, seed yield and 100 seed weight for checking genetic purity in pea, common vetch bean (*Vicia sativa* L.) and broad bean (*Vicia faba* L.) (Higgins *et al.*, 1988).

MATERIAL AND METHODS

The experimental material consisted of 25 accessions collected from different parts of India were genetically catalogued as per IBPGR descriptor list. The experiment was laid out in a Randomized Block Design with two replications. Each replication consisted of 25 plots, one for each type. Different quantitative as well as qualitative characters were taken from the selfed seeds and the resultant plants. The average values of the characters per plant and seed for every genotype were worked out and were used for further statistical analysis. The main vine length was measured from the collar region to the tip of the main vine after the final harvest. The length of the tendril and the internodal length at three different points of the vine were recorded and average was taken. The number of days to first male and female flower opening was counted from the date of germination to the date when the first male and female flower opened. The

Table - 1 : Analysis of variance for 24 characters in 25 accessions of snake gourd

Source of variation	DF	Mean sum of squares											
		Main vine length (m)	Internodal length (cm)	Peduncle length (cm)	Days to first male flower anthesis	Days to first female flower opening	Male flower per plant	Female flower per plant	Sex ratio	Days to fruit maturity	Days to first harvest for seed	Fruit length (cm)	Fruit girth (cm)
Replication	1	2.213	0.423	6.480	0.320	0.080	5491.520	0.040	1.941	0.720	0.180	20.737	0.001
Treatment	24	0.784**	11.924**	102.92**	4.228**	8.000**	292270.1**	54.1**	80.41**	3.030**	17.20**	959.2**	37.04**
Error	24	0.039	0.591	0.230	1.278	0.661	3932.020	0.747	2.888	0.470	0.680	3.868	0.033
CD(0.050)		0.4076	1.587	0.9898	2.333	1.681	129.4	1.778	3.507	1.415	1.702	4.059	0.3749

Source of variation	DF	Mean sum of squares									
		Flesh thickness (cm)	Fruits per plant	Fruit weight (g)	Yield per plant (kg)	Seeds per fruit	100 seed weight (g)	Seed length	Seed width	Seed thickness	Seed size index
Replication	1	0.020	19.220	274.248	0.601	3.591	0.080	0.032	0.003	0.049	0.503
Treatment	24	0.563**	12.353**	33327.9**	3.761*	291.455**	15.92**	1.162**	0.474**	0.141**	758.94**
Error	24	0.103	0.220	195.76	0.081	0.570	0.413	0.032	0.026	0.105	7.377
CD(0.050)		0.6624	0.9681	28.88	0.5874	1.558	1.322	0.3692	0.332	NS	5.606

* P = 0.05 ** P = 0.01

number of male and female flowers was counted every day as and when they open, starting from the day of opening of first male and female flower and the sex ratio was calculated as a ratio of the number of male flower to female flowers per plant. The length of the peduncle at three different points of the vine was recorded, and average was taken. The length, girth and weight of the first six fruits harvested from each plant were recorded and the average worked out. The number of days to fruit maturity was counted starting from the day of female flower opening up to vegetable harvest pertaining to first six fruits. The number of days taken for the first fruit to harvest for seed was counted starting from the day of female flower opening. The number of fruit to harvest for seed was counted starting from the day of female flower opening. The number of fruits in each plant was counted as and when the fruits were harvested and finally added together. The weights of all the harvested fruits from each plant were recorded and added up to get the total yield per plant.

Number of seeds per plant was counted from the first six fruits harvested from each plant and the average was worked out. The seeds obtained from first five fruits were taken for estimating the 100 seed weight. Seed length, seed width and seed thickness was measured with vernier calipers and average of five seeds was recorded. Seed size index was obtained when seed length was multiplied with seed width. Seeds after extraction from fruit were subjected to germination test and number of days taken for germination was counted.

Qualitative characters like leaf lobes (shallow/intermediate/deep), leaf pubescence (sparse/ intermediate/dense), tendrils(short (up to 5 cm)/intermediate (6-10 cm), fruit skin colour

Table - 2 : Keys developed for snake gourd

Acc. No.	Growth Characters			Fruit characters			Seed characters			
	Leaf lobes	Leaf pubescence	Tendrill length (cm)	Fruit skin colour	girth (cm)	length (cm)	weight (g)	Seed size index (mm ²)	100 Seed weight (g)	Seed coat colour
TA 114	Deep	Dented	32.40	Green with white stripes	22.65	76.25	356.6	160.48	32.0	Brown
TA 95	Deep	Dented	31.20	White with green stripes	14.96	90.2	541.4	136.26	22.5	Grey
TA 107	Shallow	Smooth	37.10	Green	23.27	76.85	407.5	140.6	30.0	Brown
Co-2	Shallow	Dented	29.35	Green	22.14	31.10	510.0	156.80	28.0	Brown
TA 111	Deep	Dented	34.20	Green	14.8	64.75	480.5	148.36	26.0	Brown
TA 112	Deep	Dented	33.25	Green	22.28	34.8	391.6	173.25	30.0	Brown
TA 113	Deep	Dented	25.20	Green with white stripes	15.53	86.05	406.8	164.49	30.0	Brown
Co-1	Shallow	Dented	30.45	Green with white stripes	12.61	68.75	615.3	148.68	28.5	Grey
TA 103	Shallow	Dented	34.65	Green with white stripes	17.40	66.45	359.3	164.52	30.0	Grey
TA 116	Shallow	Dented	27.60	Green with white stripes	11.70	110.40	502.9	168.53	27.5	Brown
TA 115	Shallow	Dented	33.60	Green with white stripes	12.42	90.20	390.1	176.05	30.0	Brown
TA 108	Shallow	Smooth	33.20	Green with white stripes	16.18	98.15	639.5	178.63	30.0	Brown
TA 102	Intermediate	Smooth	28.70	White	10.30	115.80	767.5	151.92	28.5	Grey
TA 109	Intermediate	Dented	33.85	Green with white stripes	23.55	87.50	506.9	159.67	25.5	Tan
TA 106	Shallow	Dented	28.80	Green with white stripes	21.66	78.95	611.2	170.71	24.5	Brown
TA 119	Shallow	Dented	30.00	Green	19.05	93.70	508.5	173.55	30.0	Brown
PKM-1	Intermediate	Dented	29.75	Green with white stripes	11.05	105.40	339.7	159.80	30.0	Grey
TA 104	Intermediate	Dented	36.3	White with white stripes	16.8	105.5	776.9	144.97	24.5	Brown
MDU-1	Deep	Smooth	31.4	Green with white stripes	23.26	54.9	260.4	163.09	26.5	Tan
Kaumudi	Shallow	Dented	32.6	White with green stripes	14.05	95.75	458.7	154.04	28.0	Grey
TA 110	Shallow	Smooth	35.15	White	18.09	55.90	464.6	167.13	32.5	Brown
TA 105	Deep	Smooth	32.95	White	15.24	61.35	292.7	151.84	24.5	Brown
TA 118	Shallow	Smooth	41.80	White	14.20	79.20	420.2	174.79	25.5	Grey
TA 19	Deep	Smooth	29.60	Green with white stripes	20.1	68.9	467.0	176.09	26.5	Brown
TA 117	Deep	Dented	40.0	Green with white stripes	12.39	94.82	398.5	146.72	22.0	Brown

Table - 3 : Treatment means of snake gourd genotypes (seed characters)

Accession		Mean of sum characters					
No.	Seed/fruit	Seed weight(g)	Seed length (mm)	Seed width (mm)	Seed dormancy	Seed size index mm ²	Seed thickness (mm)
1	34.9	28.5	15.68	9.69	7.0	151.92	5.11
2	41.8	30.0	15.85	10.38	8.0	164.52	5.45
3	62.9	28.0	15.72	9.98	8.0	156.80	4.88
4	43.1	26.5	16.54	9.86	8.5	163.09	4.39
5	56.9	24.5	14.90	9.73	7.5	144.97	4.72
6	35.9	24.5	15.78	9.60	14.5	83.91	5.22
7	38.3	26.5	16.47	10.69	8.5	176.09	5.40
8	52.7	24.5	16.59	10.29	8.5	170.71	5.13
9	49.9	30.0	15.11	9.31	6.5	140.60	4.96
10	32.3	30.0	17.39	10.28	7.5	178.63	5.01
11	71.8	25.5	16.42	9.73	7.5	159.67	5.43
12	53.1	28.0	15.56	9.90	8.0	154.04	5.05
13	35.9	28.5	15.78	9.43	6.0	148.68	5.27
14	71.2	22.5	15.20	8.97	7.5	136.26	4.82
15	61.4	32.5	17.66	9.47	15.0	167.13	5.33
16	43.3	26.0	15.65	9.48	6.0	148.36	5.08
17	69.8	30.0	16.63	10.42	8.5	173.25	4.63
18	47.6	30.0	15.73	10.46	15.5	164.49	4.96
19	38.8	32.0	15.49	10.36	8.5	160.48	4.83
20	50.3	30.0	16.67	10.57	18.0	176.05	4.99
21	56.5	27.5	17.66	9.55	18.5	168.53	5.06
22	61.8	22.0	15.70	9.35	7.5	146.72	4.73
23	54.6	25.5	16.63	10.51	7.5	174.79	4.81
24	35.8	30.0	15.33	10.43	17.5	159.80	4.71
25	42.9	30.0	16.66	10.42	18.0	173.55	5.12

(green/white/green with white stripes/white with green stripes), fruit length (small/medium/large), Seed surface (Smooth/Wrinkled/Pitted/Creased), Seed surface luster (Dull/Intermediate/Glossy), Seed coat colour (White/Tan/Brown/Gray/Black) and Seed shape (Round/Elliptical/Oval/Acorn) were considered as marker characters for varietal identification. The data obtained from the studies were subjected to following statistical analysis.

RESULTS AND DISCUSSION

The results of analysis of variance for 24 characters of 25 snake gourd accessions are presented (Table 1). The analysis showed that significant difference between the accessions for all the characters studied except seed thickness. The mean performance of 25 accessions is presented Table 3 and Table 4. The morphological characteristics utilized in the

present study were typical for the accessions and were able to characterize the varieties during the field crop inspection. By the combination of two or more morphological characteristics belonging to different parts of the plant it is possible to characterize the varieties. Correlation coefficients among seed, growth and yield characters (Table 5) shows that seeds per fruit was found to be significantly and negatively correlated with days to male flower opening and days for fruit maturity ($r=-0.407$ and $r=-0.441$).

Significant negative correlation was observed between seed coat colour and fruit girth ($r=-0.624$). Seed shape was found to be significantly and negatively correlated with leaf size ($r=-0.501$) and positively correlated with leaf colour ($r=0.457$). Seed shape was also found to be significantly and positively correlated with

Table - 4 : Mean performance of snakegourd genotypes for growth and yield characters

Accession No.	Tendrill length (cm)	Internodal length (cm)	Main vine		Days to		Sex ratio	Peduncle length (cm)	Flesh thickness (mm)	Fruit girth (cm)	Fruit length (cm)	Days to maturity	Days to first harvest	Fruits/plant	Fruit weight (g)	Yield/pla nt (kg)
			length (m)	flower opening	male opening	female opening										
TA102	28.70	17.75	6.61	43.0	53.0	1212.0	39.0	31.1	15.8	5	10.30	115.80	38.5	9.5	767.5	6.71
TA103	34.65	15.75	4.97	38.5	47.5	1525.0	38.0	40.2	14.8	4	17.40	66.45	43.5	8.0	359.3	3.065
CO2	29.35	17.00	5.74	39.0	49.5	1676.5	41.5	40.4	18.8	5.5	22.14	31.10	43.5	13.5	510.0	6.065
MDU1	30.95	26.00	5.41	37.5	46.5	1005.0	38.5	26.1	12.8	5	23.19	55.05	41.5	13.5	261.3	3.795
TA104	35.90	15.25	4.26	37.5	45.0	896.0	27.5	32.6	35.5	5	16.73	106.45	41.5	11.5	763.5	7.365
TA105	32.95	17.00	4.82	37.5	46.5	896.0	27.5	32.6	13.0	6	15.24	61.35	38.5	16.5	292.5	4.7
TA19	29.60	16.75	5.40	38.5	49.0	701.0	31.5	22.2	15.5	6	20.10	68.90	38.5	8.0	467.0	3.555
TA106	28.80	18.00	4.79	36.5	46.5	1192.0	37.5	31.8	11.5	5	21.66	78.95	38.0	8.5	611.2	5.135
TA107	37.10	22.70	5.46	38.5	46.5	1723.5	45.5	37.9	23.8	5	23.27	76.85	36.5	11.5	407.5	4.55
TA108	33.20	21.50	5.64	41.0	50.5	1222.0	37.5	32.6	26.8	6	16.18	98.15	41.5	11.5	639.5	6.525
TA109	33.85	18.75	4.40	37.0	48.5	1204.5	40.5	29.7	23.3	5	23.55	87.50	36.5	7.5	506.9	3.525
KAUMUDI	32.60	18.75	5.48	37.0	47.5	986.0	36.5	27.0	16.3	5	14.15	95.75	37.5	10.5	458.7	4.6
Co-1	30.45	22.75	4.56	38.0	49.5	1595.0	39.5	40.4	34.5	5	12.61	68.75	39.5	12.5	615.3	6.945
TA95	31.20	16.75	5.55	37.5	48.5	1747.5	45.5	38.4	8.5	4.5	14.96	90.20	40.5	16.5	541.4	7.715
TA110	35.15	17.00	4.85	37.5	47.5	921.0	29.5	31.2	14.0	5	18.09	55.90	40.0	12.5	464.6	5.66
TA111	34.20	19.65	5.35	41.0	50.5	1626.5	46.5	35.0	11.0	6	14.80	64.75	41.0	9.5	480.5	4.45
TA112	33.25	18.00	4.68	38.5	48.5	1605.5	39.0	41.0	19.5	6	22.28	34.80	36.5	12.5	391.6	4.615
TA113	25.20	19.50	4.46	39.5	51.0	1599.0	39.0	41.0	27.0	5	15.53	86.05	41.0	10.5	406.8	4.735
TA114	32.15	18.25	5.86	39.0	47.0	2181.0	45.5	47.9	24.5	5	22.65	76.25	38.5	11.0	356.6	3.735
TA115	33.60	19.75	5.45	38.5	49.5	1305.0	35.5	36.7	17.5	4.5	12.42	90.20	36.5	8.0	390.1	2.905
TA116	27.60	18.00	4.85	38.0	47.5	1435.0	39.5	36.3	26.0	4	11.70	110.40	47.5	12.5	502.9	5.925
TA117	40.00	16.75	6.42	39.0	44.5	643.0	29.5	21.8	14.0	5	12.39	94.80	42.5	10.5	398.5	3.85
TA118	41.80	20.50	4.94	38.5	47.5	837.0	31.0	27.0	24.5	5	14.20	79.20	39.5	9.5	420.2	3.87
PKM1	29.75	18.50	5.47	38.5	45.5	1105.0	34.5	32.0	13.0	5	11.05	105.40	46.5	11.5	339.7	4.3465
TA119	30.00	19.50	6.29	37.0	46.5	1168.5	39.5	29.6	16.5	5.5	19.05	93.70	39.5	7.5	508.5	3.74
CD(0.05)	2.343	1.587	0.4076	2.333	1.681	129.4	1.778	3.507	0.9898	0.6624	0.3749	1.415	1.702	0.9681	28.88	0.5674

Table - 5 : Correlation coefficients among seed, growth and yield characters

	Seeds/fruit	Seed coat colour	Seed shape	100 seed weight	Seed width	Leaf size	Leaf lobes	Leaf colour	Days to male flower opening	Days to female flower opening	Sex ratio	Fruit girth	Days to fruit maturity	Yield/plant	Seed size index
Seed surface	0.005														
Seed coat colour	-0.217														
Seed shape	0.167	0.231													
100 seed weight	-0.329	0.061	-0.449*	0.411*											
Seed width	-0.306	-0.008	-0.369	0.417*	0.012										
Leaf size	0.108	0.125	-0.501**	0.194	-0.072	-0.490*									
Leaf lobes	-0.063	-0.168	0.194	-0.259	0.082	-0.441*	0.301								
Leaf colour	-0.056	0.094	0.457*	-0.275											
Days to male flower opening	-0.407*	0.203	-0.339	0.207	0.030	0.159	0.210	-0.116	0.145	0.291					
Sex Ratio	-0.025	0.145	-0.112	0.483*	0.011	0.251	-0.018	-0.289	-0.349	-0.186	0.135				
Fruit girth	0.262	-0.624**	-0.182	0.130	0.158	0.104	0.029	-0.161							
Days to fruit maturity	-0.441*	0.158	-0.329	0.157	0.200	-0.152	0.005	-0.157	0.444	0.216	-0.148	-0.266	-0.271		
Fruit/plant	0.135	0.061	0.496*	-0.187	-0.540**	-0.154	0.336	-0.050	-0.110	-0.126	0.241	-0.056	0.120	0.556**	
Yield/plant	0.106	0.290	0.394	-0.180	-0.532**	0.099	0.359	-0.153	0.165	0.242	0.171	-0.262	0.183	-0.603**	-0.245
Seed size index	0.072	-0.079	-0.639**	0.421*	-0.603**	0.495*	-0.340	-0.324	0.074	0.196	-0.053	0.151	0.052	-0.384*	-0.087
Seed thickness	-0.169	0.104	-0.085	0.142	-0.004	0.083	-0.399*	0.175	-0.043	0.238	0.011	-0.038			-0.035

* =5% level of significance

** =1% level of significance

fruits per plant and yield per plant ($r = 0.496$ and $r = 0.394$).

Hundred seed weight was found to be significantly and negatively correlated with leaf size ($r = -0.501$) and positively correlated with sex ratio ($r = 0.483$). Seed width was found to be significantly and negatively correlated with fruits per plant and yield per plant ($r = -0.540$ and $r = -0.532$). Seed thickness was found to be significantly and negatively correlated with leaf lobes and fruits per plant ($r = -0.399$ and $r = -0.384$). Seed size index was found to be significantly and positively correlated with leaf size ($r = 0.495$) and negatively correlated with fruits per plant ($r = -0.603$). Sharma and Tyagi (1977) suggested that seed quality has a definite effect on plant development leading to flowering and it is manifested as an interaction between seed quality and the genotype.

Keys were prepared based on the primary diagnostic characters of both seed and plant (Table 2). The major diagnostic characters that were used for developing keys are leaf pubescence, leaf lobes, tendril length, fruit skin colour, fruit girth, fruit length, fruit weight, 100 seed weight, seed size and seed coat colour. The varietal identification keys developed by using leaf characters and fruit characters in *Pisum sativum*, *vicia sativa* and *Vicia faba* are comparable in this case (Martinello, 1992).

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Residual Nutrient Status as Influenced by Nitrogen and Sulphur Application to Mustard Crop

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ABSTRACT

A field experiment was conducted on sandy clay loam soil at Agricultural College farm, Bapatla during *rabi* 2002. The study revealed that the availability of nutrients N, P, K and S in soil after harvest were significantly influenced by increased levels of N and S.

Key words : Mustard, Residual Nutrient, Nitrogen, Sulphur

Mustard occupy second position in area and production after groundnut in our country. With the intensification of agriculture and ever increasing demand for nutrients made by crops, the traditional boundaries between primary and secondary nutrients are becoming narrower. The yield maximization can not be expected from the use of NPK fertilization alone, but sulphur must be included in the fertilization programmes. In the present investigation, the effect of sulphur along with nitrogen on residual nutrient status was studied.

MATERIAL AND METHODS

A field experiment was carried out in a Randomized Block Design with factorial concept during *rabi* season 2002 at Agricultural College Farm, Bapatla. The soil was sandy clay loam with pH 7.2 and medium in available nitrogen, low in phosphorus and sulphur and high in potassium status. The treatments consisted of 4 doses of N (0, 40, 80 and 120 kg ha⁻¹) and 4 doses of S (0, 30, 60 and 90 kg ha⁻¹). N and P were supplied through diammonium phosphate (18:46:0) and KH₂PO₄, while the balance of nitrogen was made up with urea (46%N).

Potassium was supplied through muriate of potash (60% K₂O), after deducting the amount supplied through KH₂PO₄, while the source of sulphur was gypsum. Soil samples were analysed for pH, EC, available N, P₂O₅, K₂O and S by following the standard procedures.

RESULTS AND DISCUSSION

There was no significant difference among different levels of nitrogen and sulphur and also among their interactions with regard to pH and EC of soils at harvest.

There was a significant increase in the soil available nitrogen from N₀ to N₁₂₀. The highest value (252.55 kg ha⁻¹) was recorded by 120 kg N ha⁻¹ which might be due to adequate availability of this nutrient, but the crop utilized only part of it. The N status increase was not much with regard to S application. Similar findings were reported by Dubey and Khan (1993).

Available phosphorus in soil increased with increase in nitrogen and sulphur levels and the highest (46.72 kg ha⁻¹) was recorded by 120 kg N ha⁻¹ and 90 kg S ha⁻¹. Similar increase in available phosphorus with the application of

Table : Effect of N and S levels on residual nutrient status.

	pH	EC d S m ⁻¹	Available N (kg ha ⁻¹)	Available P ₂ O ₅ (kg ha ⁻¹)	Available K ₂ O (kg ha ⁻¹)	Available S (kg ha ⁻¹)
Nitrogen (kg/ha)						
0	7.08	0.37	210.18	30.85	389.56	17.28
40	7.06	0.37	233.60	35.36	436.61	21.92
80	7.05	0.38	244.14	40.03	460.59	26.20
120	6.92	0.45	252.55	46.72	470.26	29.40
CD (P=0.05)	-	-	29.16	4.69	43.15	3.01
Sulphur (kg/ha)						
0	7.05	0.37	211.44	33.22	397.51	17.46
30	7.02	0.37	236.72	35.51	440.76	21.32
60	7.04	0.38	239.04	38.70	452.46	26.42
90	7.00	0.45	253.16	45.75	466.29	29.55
CD (P=0.05)	-	-	29.16	4.69	43.15	3.01

sulphur was reported by Raikhy *et al.* (1985) in cowpea crop.

Available potassium in soil increased with increase in nitrogen and sulphur levels and the highest was recorded by the application of 120 kg N ha⁻¹ and 90 kg S ha⁻¹ which might be due to its adequate availability.

There was an increase in available sulphur in soil with increased levels of nitrogen and sulphur. This is in accordance with the findings of Dubey and Khan (1993) who reported an increasing trend in residual S status with increasing levels of S. Increased sulphur availability at higher rates of N might be due to more vegetative as well as root growth which oxidizes the reduced sulphur to sulphate by microbial activity in association with the roots of rice in the rhizosphere as reported by Ahmed *et al.*, (1988).

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Available Soil Sulphur Status in Relation to Soil Properties of Two Alfisols and an Inceptisol

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ABSTRACT

Two red lateritic soils, one red lateritic soil (Salbani series) in West Midnapore district, West Bengal and the other red lateritic soil (Madnahari series) in Jamui district, Bihar and one old alluvial soil (Chitrokut series) in Chitrokut district, Madhya Pradesh, having gradients in physical and chemical characteristics were studied to relate available soil sulphur status to soil factors. The extractants in decreasing order of the mean value of extractable S were : 0.5 N $\text{NH}_4\text{OAc} + 0.25$ N HOAc (15.8 mgkg^{-1}) > 0.03 N NaH_2PO_4 (15.3 mgkg^{-1}) > 0.025 N CaCl_2 (14.6 mgkg^{-1}) > 0.1 N H_3PO_4 (11.5 mgkg^{-1}) > 0.001 N HCl (8.1 mgkg^{-1}). Correlation coefficients among available soil sulphur and soil properties were examined.

Key words : Available sulphur, Soil properties, Alfisols, Inceptisols.

Sulphur, in the form of sulphate, is essential for all plants as it is involved in various metabolic and enzymatic processes. Although a large number of soil tests for available S has been tried by many workers (Chesnin and Yien, 1951; Ensminger, 1954; Williams and Steinbergs, 1959), each one of these methods has its own limitations and drawbacks, e.g. extraction of extremely small amounts of sulphur and interference of other ions etc. No single soil test procedure could be successfully adopted for varying soil-plant-climatic conditions. In view of the high sulphur demand of oil seeds and pulses, and fast appearing S deficiency in soils, a need has been felt to delineate the S-deficient areas.

Sulphur status varies with depth depending upon drainage characteristics of the soils. Distribution of available sulphur, and their interrelationship with some important soil

characteristics decide the S supplying power of a soil by influencing its release and dynamics in soils. The present investigation was, therefore, undertaken to study the vertical distribution of available S in two Alfisols and an Inceptisol from India selected to represent typical example of soils and their interrelationship with some important soil characteristics.

MATERIAL AND METHODS

For the present investigation two red lateritic soils, one red lateritic soil (Salbani series) in West Midnapore district, West Bengal and the other lateritic soil (Madnahari series) in Jamui district, Bihar and one old alluvial soil (Chitrokut series) in Chitrokut district, Madhya Pradesh, India, were collected based on the information of soil survey conducted by All India Soil and Land Use Survey, Kolkata Centre. Data on physicochemical properties are given in table 1.

Table - 1: Physicochemical properties of soils

Horizon (m)	pH (1 : 2.5)		EC (1 : 5) dSm ⁻¹	Organic carbon (g kg ⁻¹)	Mechanical Analysis (g kg ⁻¹)		Texture*	C.E.C. c mol (P+) kg ⁻¹
	H ₂ O	1 (M) KCl			Silt	Clay		
Pedon A : Salbani Series : Fine loamy mixed hyperthermic Typic Plinthaqualfs.								
0.00-0.13	5.2	4.0	0.03	6.9	320	205	l	6.5
0.13-0.25	5.5	4.2	0.02	4.3	190	235	sci	3.9
0.25-0.40	6.2	4.8	0.02	2.2	170	235	sci	2.9
0.40-0.58+	6.4	4.9	0.02	1.9	110	270	sci	2.2
Mean	5.8	4.5	0.02	3.8	198	236	sci	3.9
Pedon B : Maknahari Series : Fine loamy mixed hyperthermic Typic Plinthustalfs.								
0.00-0.09	6.3	5.0	0.02	4.3	90	203	sci	14.6
0.09-0.22	6.8	5.3	0.02	1.8	200	163	sl	10.2
0.22-0.41	6.9	5.4	0.02	0.7	180	183	sl	9.2
0.41-0.64+	6.9	5.4	0.03	0.7	190	173	sci	7.6
Mean	6.7	5.3	0.02	1.9	165	180	sl	10.4
Pedon C : Chitrukut Series : Fine loamy mixed hyperthermic Oxic Haplustepts.								
0.00-0.12	6.7	5.2	0.10	3.6	140	141	sl	18.9
0.12-0.30	6.7	5.4	0.30	6.3	180	261	sci	22.1
0.30-0.53	7.1	5.6	0.30	2.2	220	242	sci	16.8
0.53-0.79+	6.6	5.0	0.10	2.2	200	285	sci	12.5
Mean	6.7	5.3	0.20	3.6	185	232	sci	17.6
Grand mean	6.4	5.0	0.08	3.1	183	216	sci	10.6

* l : Loam; sci : Sandy clay loam; sl : Sandy loam.

The various extractants of available $\text{SO}_4\text{-S}$ were as followed : (i) 0.025 N CaCl_2 ; (ii) ammonium acetate-acetic acid at pH 5.0; (iii) 0.001 N HCl; (iv) 0.03 N NaH_2PO_4 ; (v) 0.1 N H_3PO_4 (Hoeft *et al.*, 1973). The extracting procedure consisted of shaking 20 g of soil with 50 ml of extracting solution for 30 min, adding 0.1 g of activated charcoal, and shaking for an additional 15 minutes. The samples were filtered through Whatman No. 42 filter paper. Sulphur in the extracts was estimated turbidimetrically (Chesnin and Yien, 1951).

RESULTS AND DISCUSSION

Distribution of extractable $\text{SO}_4\text{-S}$ with different methods:

CaCl_2 -extractable S

Results on the available sulphate sulphur extracted with 0.025 N CaCl_2 solution showed that in various soil profiles, this fraction ranged from 11.5 to 16.7 mg kg⁻¹ with a mean of 14.6 mg kg⁻¹ (Table 2). The amount of CaCl_2 extractable sulphur may be due to the presence of calcium ion in the extract probably favouring dissociation of some organically bound sulphate ion (Beaton *et al.*, 1968). The average CaCl_2 extractable S content of 14.6 mg kg⁻¹ was considerably lower than values reported for some Inceptisols of Delhi (Gowrisankar and Shukla, 1999), for some Alfisols of West Bengal (Pramanik and Dolui, 2001), for some Entisols and Alfisols of West Bengal (Dolui and Guhathakurta, 1988) and the Dumka and Laximpur series of South Chotanagpur in Bihar (Kumar *et al.*, 1994) but was considerably higher than values reported for Debatoli series of South Chotanagpur in Bihar (Kumar *et al.*, 1994), for some Alfisols of North Karnataka (Venkatesh and Satyanarayana, 1999) and for some Mollisols of

Table 2 : Extractable $\text{SO}_4\text{-S}$ with different extractants (mg S kg^{-1} soil)

Horizon (m)	Extractable S ^a				
	CaCl_2	NH_4OAc	HCl	NaH_2PO_4	H_3PO_4
Pedon A : Salbani Series : Fine loamy mixed hyperthermic Typic Plinthaqualfs					
0.00-0.13	13.7	14.0	8.1	15.0	11.5
0.13-0.25	12.8	14.2	9.2	14.8	11.0
0.25-0.40	13.0	13.9	10.0	17.0	10.0
0.40-0.58+	15.1	15.0	9.4	12.9	12.8
Mean	13.7	14.3	9.2	14.9	11.3
Pedon B : Madnahari Series : Fines loamy mixed hyperthermic Typic Plinthustalfs					
0.00-0.09	16.0	17.0	8.9	16.7	11.8
0.09-0.22	15.4	18.0	6.3	16.1	12.2
0.22-0.41	11.5	15.5	6.1	13.5	10.1
0.41-0.64+	15.2	13.2	5.0	14.8	13.4
Mean	14.5	15.9	6.6	15.3	11.8
Pedon C : Chitrokut Series : Fine loamy mixed hyperthermic Oxic Haplustepts					
0.00-0.12	16.0	17.0	9.0	15.8	9.9
0.12-0.30	16.7	18.2	9.8	16.0	12.0
0.30-0.53	15.0	18.0	8.1	14.2	12.6
0.53-0.79+	14.8	16.2	7.2	17.0	10.8
Mean	15.6	17.4	8.5	15.7	11.3
Grand mean	14.6	15.8	8.1	15.3	11.5

Tarai region of Uttaranchal (Teotia *et al.*, 2001). Sulphate sulphur was higher in surface layer of Salbani and Madnahari series. The higher concentration in surface soil is probably due to greater plant and microbial activity and mineralization of organic matter. These results revealed that mean values of CaCl_2 extractable S of the soil series followed the order : Chitrokut 15.6 mgkg^{-1} > Madnahari 14.5 mgkg^{-1} > Salbani 13.7 mgkg^{-1} .

NH_4OAc - extractable S

The amount of available S extracted by NH_4OAc in acetic acid solution varied widely. NH_4OAc extractable S in the soils ranged from 13.2 to 18.2 mgkg^{-1} with an average of 15.8 mgkg^{-1} . The average NH_4OAc extractable S content (15.8 mgkg^{-1}) was considerably lower than that reported by Singh *et al.*, (1996) for acidic soils of Bihar, Dolui and Guhathakurta (1988) for some soils of West Bengal and Dolui and Bandyopadhyay (1983) for North Bengal forest soils and was considerably higher than

values reported for some Alfisols of India (Dolui and Chakrabarti, 1988), for some Alfisols of West Bengal (Pramanik and Dolui, 2001), for some Mollisols of Tarai region of Uttaranchal (Teotia *et al.*, 2001), for some red and lateritic soils of West Bengal (Dolui and Nayek, 1981). In general, subsurface soils contained higher available sulphur compared to surface soils. This may be attributed to the accumulation of sulphur in subsurface layers. In order of S extractability by NH_4OAc these soil series can be arranged as : Chitrokut 17.4 mgkg^{-1} > Madnahari 15.9 mgkg^{-1} > Salbani 14.3 mgkg^{-1} .

HCl- extractable S

The amount of easily soluble S (0.001 N HCl extractable) varied from 5.0 to 10.0 mgkg^{-1} with a mean of 8.1 mgkg^{-1} . HCl dissolved insoluble sulphate co-crystallizing with CaCO_3 (Williams and Steinbergs, 1959). Low content of this form of sulphur may be ascribed to natural leaching under the influence of high rainfall or otherwise which has been adequate to prevent

accumulation of sulphate in different horizons as well as due to low content of CaCO_3 in these soils. The average HCl-extractable S content of 8.1 mg kg^{-1} was rather lower as compared to the values reported for some Alfisols of West Bengal (Pramanik and Dolui, 2001), for Ludhiana soils of Punjab (Arora and Takkar, 1988) and for acid soils of Bihar (Mahto *et al.*, 1992) and was higher than value reported for Dolui and Guhathakurta (1988) for some soils of West Bengal. The results indicated that mean values of HCl extractable S followed the sequence : Salbani 9.2 mg kg^{-1} > Chitrokut 8.5 mg kg^{-1} > Madnahari 6.6 mg kg^{-1} which also followed the decreasing trend of organic carbon, silt and clay and increasing trend of pHw and pHk and H_3PO_4 -extractable S.

NaH_2PO_4 -extractable S

The average content of adsorbed SO_4 -S extracted by NaH_2PO_4 was 15.3 mg kg^{-1} in the range of 12.9 to 17.0 mg kg^{-1} (Table 2). The phosphate solution i.e. NaH_2PO_4 extracted more S than the other reagents except NH_4OAc in the present investigation. The observation, that phosphate containing solution extracted higher amount of S, could indicate the presense of some adsorbed sulphate which, however, can not be high enough at the pH above neutrality (Harward and Reisenauer, 1966). The NaH_2PO_4 extracted S content of 15.3 mg kg^{-1} was higher than values reported for some alluvial soils of India (Dolui and Chakrabarti, 1998) and was considerably lower than values reported for some acidic soils of Bihar (Singh *et al.*, 1996), red, lateritic and alluvial soils of West Bengal (Dolui and Nandi, 1989), for some soils of West Bengal (Dolui and Guhathakurta, 1988) and for some Alfisols of West Bengal (Pramanik and Dolui, 2001). The

soil series in order of their decreasing mean NaH_2PO_4 extractable S are arranged as Chitrokut 15.7 mg kg^{-1} > Madnahari 15.3 mg kg^{-1} > Salbani 14.5 mg kg^{-1} which also followed the decreasing CaCl_2 and NH_4OAc -extractable S.

H_3PO_4 -extractable S

The amount of available sulphate S extracted by H_3PO_4 varied from 9.9 to 13.4 mg kg^{-1} (average 11.5 mg kg^{-1}). The average H_3PO_4 extractable S content (11.5 mg kg^{-1}) was rather lower as compared to the value reported by Pramanik and Dolui (2001) for some Alfisols of West Bengal and was slightly higher than value reported for some soils of West Bengal (Dolui and Guhathakurta, 1988). On an average 11.3 , 11.8 and 11.3 mg kg^{-1} H_3PO_4 -extractable S were recorded in Salbani, Madnahari and Chitrokut series. No systematic depthwise variation of this form of S was observed in any series.

Interrelationship between different forms

CaCl_2 extractable S showed significant relationship with (worked out at 1%** and 5%* levels of significance) NH_4OAc (0.58^*) and H_3PO_4 (0.60^*) extractable S. Since sulphate sulphur and other forms of sulphur are in a dynamic equilibrium, they are related significantly to each other. Similar relationships have been reported for West Bengal soils (Dolui and Guhathakurta, 1988; Pramanik and Dolui, 2001).

NH_4OAc -extractable S had significant positive correlation with NaH_2PO_4 and H_3PO_4 extractable S, the r values being 0.67^* and 0.55^* , respectively. The correlation between different forms of sulphur indicated that they extracted similar pool of S in soil.

NaH_2PO_4 extractable S showed significant negative correlation with H_3PO_4 extractable S (-0.62*). This relationship suggests intimate relationship of various forms of sulphur with each other.

Relationship with soil characteristics

pHw was significantly correlated with HC1 (0.70**), NaH_2PO_4 (0.72**) and H_3PO_4 (0.70**) extractable S. pHk had significant positive correlation with NH_4OAc , NaH_2PO_4 and H_3PO_4 extractable S, the r values being 0.55*, 0.60* and 0.76**, respectively. The significant correlation between pH and different extractable S revealed that as the pH decreases the increase in positive charge on the soil surface would cause greater adsorption of S.

Organic carbon was significantly correlated with CaCl_2 , NH_4OAc and HCl extractable S, r values being 0.73**, 0.63* and 0.60*, respectively. Out of the five, three extractants are positively and significantly correlated with organic carbon, indicating that organic matter influenced the solubility and availability of sulphur which protects itself from oxidation and precipitation of available S into unavailable form with a consequence of increasing its availability in the soils.

Clay content bears significant relation with CaCl_2 (0.68**) and HC1 (0.56*) extractable S. The correlation coefficients and regression equation between available S and dominating soil properties revealed that sulphur was positively and significantly correlated with clay and organic matter content. The result pointed out that probably soils of different location contained almost similar type of organo sulphur complexes.

Cation exchange capacity had significant positive correlation with different forms of extractable S viz., CaCl_2 (0.65*), NH_4OAc (0.75**) and HCl (0.58*) extractable S. Cation exchange capacity indicates the total negative charge of the colloid and in soil may be related to the different forms of extractable S which are also related to availability of sulphur from charge sites. This explains the above correlation.

Extractability of sulphur

Different extractants extracted varying amounts of sulphur depending upon their nature. The extractants in decreasing order of the mean value of extractable S were : 0.5 N NH_4OAc + 0.25 N NHOAc , 15.8 mgkg^{-1} > 0.03 N NaH_2PO_4 , 15.3 mgkg^{-1} > 0.025 N CaCl_2 , 14.6 mgkg^{-1} > 0.1 N H_3PO_4 , 11.5 mgkg^{-1} > 0.001 N HCl, 8.1 mgkg^{-1} .

A critical look at distribution pattern of S in the profiles revealed that all forms of sulphur follow each other with a few exceptions. Considering the critical levels of available S by mono calcium phosphate, calcium chloride, ammonium acetate-acetic acid and Morgan's reagent methods were 12.5, 10.0, 9.0 and 8.5 mgkg^{-1} , respectively (Mehta *et al.*, 1988), all series contain either marginal or sufficient amount of sulphur in the plough layer. However, the subsurface layer of the different series is deficient in sulphur and therefore, in these soils deep root crops may respond to S-fertilization.

From the above discussion, it is concluded that soil properties (especially pH, OC, clay and CEC) are the major determinants of S in different forms, and S in one form continues to transform into another maintaining a dynamic equilibrium. Further, these S forms contribute in

different proportions to the pool of available S extracted by different extractants confirming the role of soil properties in monitoring the amount of available S extracted by different extractants.

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Effect of Phosphorus and Sulphur Nutrition of Groundnut on Yield and Nutrient Uptake

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ABSTRACT

The experiment was conducted on groundnut Cv. TMV-2 in *rabi*-2002 at the Agricultural College Farm, Bapatla, with 11 treatment combinations consisting of different sources and levels of phosphorus and sulphur in simple RBD replicated thrice. Application of Phosphorus up to 60kg P_2O_5 /ha level significantly increased the pod yield of groundnut irrespective of the P source (SSP/DAP). Application of 60kg P_2O_5 /ha through DAP along with 500kg gypsum/ha applied either as topdressing at flowering or in two equal splits at sowing and at flowering or application of 60kg P_2O_5 /ha through SSP along with 250kg gypsum/ha applied as topdressing at flowering were found to be on a par in influencing pod and haulm yields of groundnut and uptake of all the nutrients studied.

Key words : Groundnut Yield, Uptake, Phosphorus and Sulphur

Groundnut (*Arachis hypogaea* L.) is the principal oilseed crop grown in India. Andhra Pradesh occupies second position both in area (18.74 Lakh ha) and production (21.43 lakh tones) of groundnut (Directorate of Economics and Statistics, 2002). Though groundnut is an important oilseed crop in Andhra Pradesh, its productivity is low. Groundnut, being a legume and oilseed crop has greater requirement for phosphorus and sulphur (Pasricha and Aulakh, 1986). Phosphorus is a constituent of enzymes, phospholipids and proteins, while sulphur is a constituent of S-containing amino acids and helps in fatty acid synthesis and also involved in conversion of reduced N into proteins in symbiotic N fixing bacteria. Since both the elements are essential and perform specific physiological functions in groundnut, lack of one or both of these result in the retardation of metabolic activity in the plant. Information on response of groundnut to P and S fertilisation in coastal sands is meager. Hence the present investigation was carried out to study response of P and S fertilisation in groundnut.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural college, Bapatla during *rabi* 2002 to study the effect of P and S application on groundnut Cv. TMV-2 under irrigated conditions in sandy soils (Ustipsammments), with neutral pH (6.8), medium available P and low available N, K and S status.

The experiment was laid out in RBD with eleven treatments and each treatment was replicated thrice.

A common dose of 35kg N and 50kg K_2O /ha was applied to all the treatments. Entire quantity of N, P and K was applied as basal dose. N in the form of urea/DAP, P in the form of SSP/DAP and K in the form of MOP were applied. The crop was grown as an irrigated crop and appropriate plant protection measures were undertaken to protect the crop from pests and diseases and the crop was maintained weed free.

Plant samples were collected at harvest stage (pods and haulms) after recording their dry

The treatmental details are as follows :

S.No	Treatments	Abbreviated as
T ₁	Control	Control
T ₂	30 kg P ₂ O ₅ /ha through DAP	DAP30
T ₃	60 kg P ₂ O ₅ /ha through DAP	DAP60
T ₄	30 kg P ₂ O ₅ /ha through SSP	SSP30
T ₅	60 kg P ₂ O ₅ /ha through SSP	SSP60
T ₆	30 kg P ₂ O ₅ /ha through SSP+250 kg gypsum/ha as topdressing	SSP30+250G.Td
T ₇	60 kg P ₂ O ₅ /ha through SSP+250 kg gypsum/ha as topdressing	SSP60+250G.Td
T ₈	30 kg P ₂ O ₅ /ha through DAP+500 kg gypsum/ha as topdressing	DAP30+500G.Td
T ₉	60 kg P ₂ O ₅ /ha through DAP+500 kg gypsum/ha as topdressing	DAP60+500G.Td
T ₁₀	30 kg P ₂ O ₅ /ha through DAP+250 kg gypsum/ha as basal+250kg gypsum/ha as topdressing	DAP30+250G.basal+250G.Td
T ₁₁	60 kg P ₂ O ₅ /ha through DAP+250 kg gypsum/ha as basal+250kg gypsum/ha as topdressing	DAP60+250G.basal+250G.Td

weights, the samples were analysed for various nutrients (N,P, K, Ca, Mg, S, Fe, Mn, Zn and Cu) and the uptake of nutrients by the crop was computed.

RESULTS AND DISCUSSION

Application of phosphorus resulted in significant increase in pod yield up to the level of 60kg P₂O₅/ha, the highest level tried. Among P sources SSP was found to be superior to DAP. The treatments DAP₆₀ + 500G. Td (T₉), SSP₆₀+ 250G. Td(T₇) and DAP₆₀+ 250G. basal + 250G. Td(T₁₁) recorded higher pod yields (2482, 2375, 2440 kg/ha respectively) and were on a par with each other (Table 1). Increase in pod yield due to P application might be due to greater association of P towards root proliferation resulting in increased uptake of other nutrients, which further increased the total number of filled pods per plant. This finding was in accordance with Subba Rao *et al* (1984). The increase in

yield due to application of gypsum was attributed to the enrichment of pod zone soil with calcium and sulphur in the form of relatively soluble gypsum which makes the soil as a better fructification medium enabling the pegs and developing pods to readily absorb adequate Ca and S to produce higher yields of good quality pods with round matured kernels with lesser number of pods. Ravikumar *et al.*, (1994) reported that application of 500kg gypsum/ha significantly increased the pod yield irrespective of methods of application i.e. either through topdressing or through split application. Uptake of nutrients followed the similar trend as in case of Yield.

Table - 1: Effect of phosphorus and sulphur on pod Yield and uptake of nutrients by groundnut

Treatmental Details	Pod Yield (Kg/ha)	Primary Nutrients(Kg/ha)			Secondary Nutrients(Kg/ha)			Micro Nutrients(g/ha)				
		N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	
Control	1262	53.8	6.66	34.6	27.6	9.40	7.52	368	104	80.1	7.71	
DAP30	1494	70.3	8.00	42.4	34.1	12.1	9.63	483	140	100	10.3	
DAP60	1830	83.1	10.6	51.7	46.7	18.5	11.1	669	194	128	11.9	
SSP30	1700	77.5	10.0	48.7	42.1	16.4	10.6	620	195	113	12.2	
SSP60	2075	96.9	12.2	58.1	52.8	22.36	13.1	761	263	145	15.6	
SSP30+250G.Td	1920	88.4	11.8	55.5	53.1	22.3	13.2	723	254	131	16.6	
SSP60+250G.Td	2375	106	14.8	72.8	70.2	29.8	16.5	952	323	163	19.9	
DAP30+500G.Td	1980	95.0	12.7	57.7	55.9	25.3	14.1	773	282	137	17.4	
DAP60+500G.Td	2482	116	16.5	74.9	76.3	33.8	17.8	985	348	175	21.6	
DAP30+250G.basal+250G.Td	1926	93.5	11.9	55.1	55.0	21.5	14.1	733	263	123	16.9	
DAP60+250G.basal+250G.Td	2440	104	13.7	75.3	69.4	29.8	16.1	958	315	168	20.3	
SEM(+)	41.5	4.21	1.00	1.30	2.54	1.35	0.60	16.4	11.6	5.85	0.72	
CD(0.05)	122	12.6	3.01	3.74	7.62	4.04	1.78	49.2	34.8	17.5	2.16	

Application of 60kg P_2O_5 /ha through DAP along with 500kg gypsum/ha applied either as topdressing at flowering or in two equal splits at sowing and at flowering or application of 60kg P_2O_5 /ha through SSP along with 250kg gypsum/ha applied as topdressing at flowering were found to be on a par in influencing pod and haulm yields of groundnut and uptake of all nutrients (Table1).

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Morphology and Classification of Southern Coastal Agro-Eco Sub Region Soils of Andhra Pradesh

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ABSTRACT

Soils of the southern costal agro-eco region represented by Madanuru village were grouped under four different landforms. The climate of the area is semiarid. The soils of inland plains were very deep, clay in texture and had blocky structure. Cracks were extending up to a depth of >50 cm and slickensides were observed in deeper layers. Hence these soils were classified under Vertisols. Transitional alluviums had sandy clay to clay texture, with cambic horizon, diagnostic for Inceptisols. Soils of sand dunes and beach sands were sandy in texture, single grained in structure, had no diagnostic horizon and were classified as Entisols.

Key words : Coastal Soils, Morphology, Classification

Andhra Pradesh is having a long coastal line of 925km. Southern Coastal Agro-Eco sub region comprising of Krishna and Godavari deltas in A.P constitutes around 2.0 M ha or 0.6% of total geographical area of India (Velayutham *et al.*, 1999) with a wide variety of soils. The land resource data of the region would help in understanding the soils better, identifying the constraints if any and planning for ideal or profitable land uses on a sustainable manner. Sound knowledge about the quality of the soils is lacking. So for the present study Madanuru village, a representative of the region is selected and studied for different soil characteristics.

MATERIAL AND METHODS

The Southern Coastal Agro-eco region is comprising of parts of Prakasam, Guntur, Krishna and west Godavari districts. Madanuru village of Kottapatnam Mandal of Prakasam district is the most representative of the region and hence taken as the pilot area for the study of different land characteristics. Madanuru village lies

approximately between the geographical coordinates of 15°2'30" to 15°22'30" N latitudes and 80°5' E to 80°7'E longitude. The pilot area was selected by ground traversing of the region. Detailed survey of the pilot area was conducted. Based on geology and physiographic position, four major landforms viz., inland plains, transitional alluviums, sand dunes and beach sands were identified. In the selected sites, profiles were opened up to '2m' or rock/hard substratum and studied in detail for morphological features as per the procedure given by Soil Survey Staff (1951). From the profiles horizon-wise soil samples were collected and analyzed for physical and physico-chemical properties by following standard procedures (Jackson 1973). The soils were classified as per USDA soil taxonomy based on soil and site characteristics into suitable taxonomic units (Soil Survey Staff, 1998). Different phases were identified based on variations in surface characteristics like slope, texture and extent of erosion.

Table - 1: Morphological Characteristics of the profiles under study :

Profile No & Horizon	Depth in cm	Colour	Texture	Structure	Boundary	Consistence	Effervescences	Other features
Pedon :1								
Ap	0-7	10YR3/3	c	sbk	cs	s&p	es	Moderately well drained, slope up to 3%, cracks of 5mm width extending up to > 50 cm, intersecting slickensides between 35 and 133 cm, 50-60% shells in C -horizon.
AB	7-35	10YR3/3	c	sbk	gs	s&p	es	
Bss ₁	35-79	10YR3/2	c	abk	gs	vs&vp	es	
Bss ₂	79-110	10YR3/2	c	abk	gs	vs&vp	es	
Bss ₃	110-133	10YR3/2	c	abk	gs	vs&vp	es	
C ₁	133-163	10YR3/3	sc	m	gs	s&p	es	
C ₂	163-200	10YR3/3	sc	m	aw	s&p	es	
Pedon : 2								
Ap	0-19	10YR3/2	scl	sbk	cs	s&p	e	Moderately well drained, slope up to 1%.
Bw ₁	19-42	10YR3/2	scl	sbk	gs	s&p	e	
Bw ₂	42-62	10YR5/2	scl	sbk	cs	s&p	es	
Bw ₃	62-92	10YR5/3	scl	sbk	gs	s&p	ev	
Bw ₄	92-116	10YR6/2	scl	sbk	gs	s&p	ev	
C ₁	116-150	10YR6/2	sl	sg		s&p		
Pedon :3								
Ap	0-20	10YR3/2	scl	sbk	cs	s&p	e	Moderately well drained, slope up to 5%, weakly developed non-intersecting slickensides below 45 cm depth.
Bw ₁	20-45	10YR3/2	scl	sbk	gs	s&p	e	
Bw ₂	45-80	10YR3/3	sc	abk	gs	s&p	e	
Bw ₃	80-108	10YR4/3	sc	abk	gs	s&p	e	
Bw ₄	108-150	10YR4/3	sc	abk		s&p	e	
Pedon :4								
Ap	0-15	10YR4/3	s	sg	cs	s ₀ &p ₀	e	Excessively drained, slope up to 15%.
C ₁	15-45	10YR5/4	s	sg	gs	s ₀ &p ₀	e	
C ₂	45-86	10YR5/8	s	sg	gs	s ₀ &p ₀	e	
C ₃	86-126	10YR5/8	s	sg	gs	s ₀ &p ₀	e	
C ₄	126-155	10YR5/8	s	sg		s ₀ &p ₀	e	
Pedon : 5								
Ap	0-12	10YR4/4	s	sg	cs	s ₀ &p ₀	e	Excessively drained, slope up to 5%.
C ₁	12-44	10YR4/6	s	sg	gs	s ₀ &p ₀	e	
C ₂	44-72	10YR5/8	s	sg	gs	s ₀ &p ₀	e	
C ₃	72-108	10YR5/8	s	sg	gs	s ₀ &p ₀	e	
C ₄	108-130	10YR6/6	s	sg	gs	s ₀ &p ₀	e	
C ₅	130-155	10YR5/6	s	sg		s ₀ &p ₀	e	

c: clay; sc: sandy clay; scl: sandy clay loam; sl: sandy loam; sc: sandy clay; s: sand; sbk: sub-angular blocky; abk: angular blocky; m: massive; sg: single grain; cs: clear smooth; gs: gradual smooth; aw: abrupt wavy; s₀: non-sticky; s: sticky; vs: very sticky; p₀: non-plastic; p: plastic; vp: very plastic.

RESULTS AND DISCUSSION

The climate of the area is semi-arid monsoonic type. Ongole and surrounding areas received a mean annual rainfall of 843 mm with lowest rainfall of 8 mm in the month of February and highest rainfall of 212 mm in the month of October. The geological formations of the area

were river and marine alluviums. The general slope of area is from N-W to S-E. A network of small ponds and dug wells drain the village. The ground water potential is moderate to good. The water level was varying from 6-7 m with seasonal fluctuations of 1-3 m. The water so occupied in the top layer of ground water table is affected with salt in the west side of Buckingham canal

Table - 2 : Physico-chemical characteristics of the profiles

Profile No & horizon	Depth in cms	pH	EC dSm ⁻¹	CaCO ₃ %	CEC *	O.C %
Pedon :1						
Ap	0-7	8.0	Tr	8.0	45.7	0.92
AB	7-35	8.4	Tr	6.0	53.0	0.42
Bss ₁	35-79	8.5	0.54	5.0	48.6	0.80
Bss ₂	79-110	8.7	1.32	4.0	59.1	0.72
Bss ₃	110-133	8.4	3.05	5.0	37.2	0.52
C ₁	133-163	8.5	3.74	2.0	16.4	0.37
C ₂	163-200	8.5	4.68	2.0	13.1	0.61
Pedon : 2						
Ap	0-19	8.1	0.98	1.0	17.3	0.59
Bw ₁	19-42	8.4	0.57	1.0	19.2	0.15
Bw ₂	42-62	8.4	0.64	1.0	15.4	0.17
Bw ₃	62-92	9.3	0.80	6.0	13.8	0.18
Bw ₄	92-116	9.4	Tr	7.0	15.7	0.18
C ₁	116-150	9.5	Tr	1.0	11.0	0.15
Pedon :3						
Ap	0-20	7.9	1.17	1.0	21.2	0.75
Bw ₁	20-45	8.3	0.63	0.0	21.2	0.40
Bw ₂	45-80	8.5	0.43	3.0	22.1	0.16
Bw ₃	80-108	8.2	0.37	2.0	24.2	0.17
Bw ₄	108-150	8.0	0.31	0.0	26.2	0.09
Pedon :4						
Ap	0-15	8.1	0.50	-	1.3	0.31
C ₁	15-45	7.6	0.22	-	1.1	0.14
C ₂	45-86	6.4	0.18	-	0.7	0.08
C ₃	86-126	6.3	0.12	-	0.6	0.13
C ₄	126-155	6.3	0.17	-	0.7	0.06
Pedon : 5						
Ap	0-12	7.1	0.57	-	1.3	0.10
C ₁	12-44	7.2	0.31	-	0.9	0.18
C ₂	44-72	6.2	0.38	-	0.6	0.31
C ₃	72-108	5.9	0.34	-	0.5	0.28
C ₄	108-130	5.8	0.26	-	0.5	0.12
C ₅	130-155	5.9	0.30	-	0.4	0.19

* c mol (p+) kg⁻¹ soil

and reverse in the east side of canal. Short and tall grasses in sandy belt and *Prosopis juliflora*, babul, palmyra etc., in other areas dominate the natural vegetation. Most of the area is intensively cultivated by different crops like groundnut, bajra, chilli, turmeric, colacacia, cashew, mango etc.

The soils of inland plains (Series A) represented by pedon 1 were very deep, clay, moderately well drained (Table 1) and formed on

nearly flat to very gently sloping uplands with a slope gradient up to 3%. Deep cracks extending up to > 50 cm depth were common in these soils. The soils were having blocky structure throughout, but in C-horizon massive structure was observed. Moderately developed intersecting slickensides were seen between 35 and 133 cm depth. High clay content, dominance of divalent cations on exchange complex and distinct

alternate dry and wet seasons might have favoured the development of vertic properties (Wilding and Tessier 1988). The surface samples were relatively high in organic matter. Cation exchange capacity (CEC) was $45.7 \text{ c mol(p+)} \text{ kg}^{-1}$ soil in the surface and 48.6 to $59.1 \text{ c mol+kg}^{-1}$ soil in sub-surface samples (Table 2). Soil reaction varied from moderately alkaline to strongly alkaline. Calcium carbonate content of the soils varied from 2-8 per cent. C-horizon was mostly developed from marine deposits and about 50-60 per cent shells occurred in this layer.

The transitional zone is considered as two soil units, represented by pedon 2 (Series B) and 3 (Series C). Soils of pedon 2 were very deep, moderately well drained and were formed from the deposits of alluvium from marine sand. These are very gently to gently sloping uplands with slopes of 0-1%. The texture of the soils varied from sandy loam to sandy clay loam and structure from single grain to sub-angular blocky. The organic carbon content was medium in surface and low in subsurface samples. CEC values ranged between 11.0 and $19.2 \text{ c mol (p+)} \text{ kg}^{-1}$ soil. Surface was moderately alkaline, whereas subsurface was strongly alkaline. Soils represented by pedon 3 were very deep, moderately well drained, very gently to gently sloping uplands. These soils have sandy clay loam to sandy clay texture and blocky structure. The organic carbon content of surface was high which might be due to the addition of crop residues. The CEC content varied from 21.2 to $26.2 \text{ c mol (p+)} \text{ kg}^{-1}$ soil. Surface was moderately alkaline, whereas subsurface was moderately to strongly alkaline.

Pedon 4 (Series D) is the representative of sand dunes. The soils were very deep, excessively drained and were developed from deposits of marine sand with slopes up to 15%. The texture was sandy and the structure was

single grained throughout. The organic carbon content was low, CEC varied from 0.6 to $1.3 \text{ c mol (p+)} \text{ kg}^{-1}$ soil, which might be due to low clay content. Surface soil was moderately alkaline, whereas sub-surface was slightly acidic to mildly alkaline.

Soils of beach sands landform represented by pedon 5 (Series E), were developed on gently sloping lands. The organic carbon content was low and the CEC was very low i.e. 0.4 to $1.3 \text{ c mol (p+)} \text{ kg}^{-1}$ soil. The soils had sandy texture, single grain structure and were excessively drained. Surface soils were neutral, whereas subsurface soils were moderately acidic to neutral.

Classification

Within soil series A, the depth of the solum was more than 150cm and the thickness of A horizon varied from 7-14cm. Calcium carbonate nodules were observed in all the horizons and these soils were classified under the order Vertisols as they have > 30% clay, intersecting slickensides and cracks extending beyond 50cm soil depth. The cracks were open for more than 90 cumulative days and the soil moisture regime was ustic, hence placed under suborder Usterts. The soils had no calcic / gypsic / salic horizon, so classified under the great group Haplusterts. The colour value of surface was less than 4 (moist) thereby kept under subgroup Typic Haplusterts. At family level the pedon was placed under fine, montmorillonitic, isohyperthermic, depending upon particle size distribution, CEC/ clay ratio and soil temperature regime. The soils of inland plains were classified as fine, montmorillonitic, isohyperthermic Typic Haplusterts. Based on variations on the surface, the soils were grouped under three phases viz., Am A₁ (series A, clay, 0-1% slope), Am B₂ (series A, clay, 1-3% slope) and Am S₂B₂ (series A, clay, 1-3% slope, moderately alkaline).

In series B, the thickness of A horizon varied from 12-24cm and B horizon from 96 to 136 cm. Calcium nodules were less in number and were present in all the horizons. In series C, the thickness of A horizon varied from 20-24cm and B horizon from 111 to >130cm. Few, very fine calcium nodules were observed. The soils of pedon 2 and 3 were classified under the order Inceptisols and suborder Ustepts due to the presence of cambic horizon and ustic soil moisture regime, respectively. Further the soils were grouped under great group Haplustepts as duripan/ calcic horizon were not present. Due to the absence of lithic contact/aquic/aridic soil moisture regime, the soils of pedon 2 were classified into Typic Haplustepts. The soils of series C were grouped under subgroup Vertic Haplustepts, due to the presence of weakly developed slickensides in deeper layers. The soils of pedon 2 and pedon 3 were classified up to family level as fine loamy (clay content is <35%), mixed (no mineral is dominant), isohyperthermic, Typic Haplustepts and fine, mixed, isohyperthermic, Vertic Haplustepts, respectively.

The soils of series B were mapped under 3 phases namely Bh A₁ (series B, sandy clay, 0-1% slope), B.iA₁ (series B, clay, 0-1% slope) and Bm A₁ (series B, clay, 0-1% slope). Different phases observed in series C based on surface characteristics were Ch A₁ (series C, sandy clay loam, 0-1% slope) CiA₁ (series C, sandy clay, 0-1% slope), Ch B₁ (series C, sandy clay loam, 1-3% slope) and Ch C₂ (Series C, sandy clay loam, 3-5%, moderate erosion).

In series D, the thickness of A horizon varied from 14-18cm. Colour was brown to yellowish brown and texture was sand throughout. In series E, the thickness of A horizon varied from 8-21cm, colour was light yellowish brown to dark yellowish brown and texture was

sand. The soils of series D and E represented by pedons 4 and 5, respectively were devoid of any diagnostic horizon and hence were classified under the order Entisols. Further due to the presence of less than 35% rock fragments and texture coarser than loamy fine sand, they were grouped in the suborder Psamments. The soils had ustic soil moisture regime and hence classified as Ustipsamments. Due to the absence of lithic contact or aridic soil moisture and presence of colour hue >2.5 YR, these soils were placed in the subgroup Typic Ustipsamments. At family level they were classified as sandy, siliceous, isohyperthermic, Typic Ustipsamments.

Different phases mapped under series D were DaA1(series D, sand, 0-1% slope), DhA1(series D, sand, 1-3% slope), DaB2(series D, sand, 1-3% slope, moderate erosion), DaC1 (Series D, sand, 3-5% slope), DaC2(Series D, sand, 3-5% slope, moderate erosion), DaC3(series D, sand, 3-5% slope, severe erosion) and DaD3 (series D, sand, 8-15% slope, severe erosion). The soils of series E were mapped under 5 units viz. EaA1(series E, sand, 0-1% slope), EcA1 (series E, sandy loam, 0-1% slope), EaB1 (series E, sand, 1-3% slope), EaB2 (series E, sand, 1-3% slope, moderate erosion) and EaC2 (series E, sand, 3-5% slope, moderate erosion).

The study revealed that Madanuru village, a representative of southern coastal agro eco sub-region had four different landforms. All the soils were deep to very deep. Soils near the coast were sandy in texture, single grain in structure. The soils covering two land forms viz. dune sands and beach sands were highly infertile due to very low cation exchange capacity. Soils of transitional alluvium and inland plains were having relatively more retention capacities of water and nutrients due to more clay and cation exchange capacity.

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Effect of Organic Manures on Soil Urease Activity

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ABSTRACT

A pot culture experiment and laboratory incubation studies were carried out to evaluate the addition of different organic manures on soil urease activity using rice as a test crop. Urease activity increased during the active growth period of rice (*i.e.*) 20-60 days after transplanting and thereafter the activity decreases to initial low levels at harvest. Among the organic manures, FYM @ 10 t ha⁻¹ recorded significantly higher soil urease activity in rice followed by green leaf manures and paddy straw. Urease activity also increased upto 60 days and thereafter decreased in the soils incubated with different organic manures.

Key Words : Organic Manures, Soil Urease

Large part of Asia is under rice cultivation and urea is the abundant Nitrogen fertilizer used along with Organic manures. Efficiency of nitrogen utilization under submerged condition is as low as 20-30% mainly due to volatilization of NH₃ and denitrification under reduced conditions. Further, the submerged soils undergo drastic physico-chemical and microbiological changes like low Eh and shift from aerobic to anaerobic and facultative anaerobic micro flora. Urease brings about hydrolysis of urea to ammonia and its activity in soil decides directly the role of hydrolysis and indirectly its loss due to volatilization and denitrification. Very limited reports are available on the effect of organic manures on soil urease activity (Lloyd and Sheaffe, 1973; Zantua and Bremner, 1976). Hence, it is felt imperative to study the effect of addition of different organic manures on soil urease activity under submerged conditions.

MATERIAL AND METHODS

Pot culture study

Five kilograms of air-dried black soil (vertisol) having pH 8.4 and organic carbon

5.9 g kg⁻¹ was taken in to earthen pots and the treatments consisted of a control, RDF, Farmyard Manure @ 10 t ha⁻¹, paddy straw @ 10 t ha⁻¹, Poultry Manure @ 1.5 t ha⁻¹, *Sesbania speciosa* @ 7.5 t ha⁻¹, *Crotalaria juncea* @ 7.5 t ha⁻¹ and *Glyricidia maculata* @ 7.5 t ha⁻¹ were imposed well before transplanting of rice. Of the recommended dose of fertilizer (RDF; 120 kg N, 60 kg P₂O₅, 30 kg K₂O ha⁻¹), half the nitrogen and entire P & K were applied as basal to all the treatments except control. The remaining half of nitrogen was applied in the form of urea at 30 DAT. Soil samples collected initially and at 20 days interval till the harvest of the crop were analyzed for urease activity (Tabatabai and Bremner, 1972) and the NH₄⁺ released was estimated by indophenol blue method (Dorich and Nelson, 1983) and expressed as mg NH₄⁺ released 5 g⁻¹ soil 2 h⁻¹.

Incubation

Soils were treated with Farmyard manure @ 10 t ha⁻¹, Paddy straw @ 10 t ha⁻¹, Poultry manure @ 1.5 t ha⁻¹ and Humic acid @ 0.5% (w/w) separately and incubation was carried out

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Table - 1: Effect of organic manures on soil urease activity under submerged conditions with rice

Organic manures	Urease activity (mg of NH_4^+ released 5 g^{-1} soil 2 h^{-1})						
	Days after transplanting (DAT)						
	0	20	40	60	80	100	120
Rice (Untreated control)	1.1	2.4	5.4	7.9	4.6	2.3	0.8
Rice + fertilizer N, P_2O_5 , K_2O @ 100-40-30 kg ha^{-1}	1.5	2.5	6.3	8.5	5.1	3.9	1.5
Rice + Farmyard manure @ 10 t ha^{-1}	1.8	7.4	11.1	27.2	9.6	5.2	1.3
Rice + Paddy straw @ 10 t ha^{-1}	1.6	3.6	6.8	9.8	6.2	4.0	1.2
Rice + Poultry Manure @ 1.5 t ha^{-1}	1.7	7.1	10.2	12.8	8.8	3.0	1.3
Rice + <i>Sesbania speciosa</i> @ 7.5 t ha^{-1}	1.3	5.3	8.8	20.4	9.3	6.4	1.4
Rice + <i>Crotalaria juncea</i> @ 7.5 t ha^{-1}	1.4	6.0	9.5	18.1	6.4	1.4	1.5
Rice + <i>Glyricidia maculata</i> @ 7.5 t ha^{-1}	1.5	5.8	8.2	16.4	9.3	6.9	1.2
Mean	1.5	5.0	8.3	15.1	8.0	4.6	1.3
Analysis of variance	F test		CD at 5%		S.Ed		
Organic manures	**		0.6		0.31		
DAT	**		0.6		0.29		
Organic manures X DAT	**		1.6		0.81		

Table - 2 : Effect of organic manures on soil urease activity in laboratory incubated vertisol

Organic manures	Urease activity (mg of NH_4^+ released 5 g^{-1} soil 2 h^{-1})					
	Days of Incubation (DOI)					
	0	20	40	60	80	120
Untreated control	0.5	0.7	0.9	1.4	0.8	0.9
Farmyard manure @ 10 t ha^{-1}	0.5	1.7	2.3	3.1	1.2	0.6
Paddy straw @ 10 t ha^{-1}	0.5	1.3	1.7	2.0	1.2	0.4
Humic acid @ 0.5% (w/w)	0.5	1.1	1.9	2.6	1.4	0.5
Poultry @ 1.5 t ha^{-1}	0.5	1.1	2.1	2.8	1.8	0.5
Mean	0.5	1.2	1.8	2.4	1.7	0.5
Analysis of variance	F test		CD at 5%		S.Ed	
Organic manures	**		0.1		0.03	
DOI	**		0.1		0.04	
Organic manures X DOI	**		0.2		0.08	

in 2 cm depth water under laboratory conditions. Soils collected at 20 days interval upto 120 days incubation period were analyzed for urease activity.

RESULTS AND DISCUSSION

Urease activity in the soils collected from rhizosphere of rice increased significantly during active growth period (upto 60 DAT) and there after decreased to minimum at harvest (Table-1). Increased enzyme activity might be due to proliferation of microorganisms due to additions of organic amendments (Lloyd and Sheaffe., 1973) and excrete of extracellular urease by rice plants (Mahapatra *et al.*, 1977). Among different organic manures, farmyard manure @ 10 t ha⁻¹ treated soils recorded significantly higher urease activity than the soils receiving green leaf manures which are on par with each other but significantly higher than control.

The soils incubated under laboratory conditions with different organic amendments also recorded an increase in urease activity upto 60 days of incubation and thereafter decreased (Table-2). Similar results were also reported by Zantua and Bremner (1976) and Lloyd and Sheaffe (1973).

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Construction of Life Table for Gram Pod borer, *Helicoverpa armigera* (Hubner) Hardwick on *rabi* Chickpea

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ABSTRACT

Studies on the life tables and budgets for two regular generations of *Helicoverpa armigera* (Hubner) Hardwick were undertaken on chickpea during *rabi* 2001-2002 in Bapatla region of Andhra Pradesh. The initial population was estimated as 77,000 and 81,000 period I larvae during the first and second generations, respectively. The final population of the adults emerged were 25730 and 31200 during the first and second generations, respectively. The key factor analysis showed an entomogenous fungus, *Nomuraea rileyi* (Farlow) Samson, as the major larval mortality factor with K value of 0.2307. Rainfall, an abiotic factor also recorded high K value of 0.0891. Also, birds (*Acridotheres tristis*, *Passer domesticus* and *Dicrurus adsimilis*) recorded high K value of 0.0766. Of the two generations, the first generation showed positive trend index ($1=1.05$) and the second generation recorded negative trend index with 0.3341 and 0.3851 generation survivals (S_0), respectively.

Key Words : Life Table, Pod borer, *Rabi*, Chickpea

Helicoverpa armigera (Hubner) Hardwick, a polyphagous and cosmopolitan pest is found widely distributed in different countries. It is found to feed on 181 plant species such as; cotton, sorghum, chickpea, pigeonpea and sunflower etc. (Sachan and Lal, 1990) and assumed the status of International pest. The life table concept provides keys to the practical understanding of pest in different agro ecosystems and to plan for an intelligent and practical manipulation of its control factors in crop habitats. With this view, life tables of *H. armigera* were constructed in Bapatla region for two regular generations to identify the key mortality factors in different growth stages and to identify the major factor affecting change in its population size.

MATERIAL AND METHODS

The study was conducted during *rabi*

2001-2002 at the Agricultural College Farm, Bapatla. A popular chickpea variety, Annigiri was raised in a pesticide free plot following appropriate agronomic practices. Basic sample units of 2x2m quadrat size were marked at ten randomly selected places for recording pest densities of different life stages. The data collected from 40sqm² area was converted to ha. Buffer strips of three rows were left on all sides of the plot. The larvae of *H. armigera* were sampled directly in the fixed sample units by considering I and II instars as period I larvae, III and IV instars as period II larvae and V and VI instars as period III larvae. Population of *H. armigera* was regularly monitored and observations were taken from the time of the appearance of the first instar larvae and continued for two successive generations. The number of eggs was calculated indirectly by sampling period I larvae after counting sterility

Table - 1: Life table and budget for first generation of *H. armigera* on chickpea during rabi 2001-2002.

Stage of the insect (x)	Number living at the beginning/ha ⁻¹	Factor responsible for d x f	Number dying during x dx	Mortality per cent 100 qx	Survival rate within Sx lx-dx lx	Numbers/ha mortality/ha ⁻¹	Log Nos./ha ⁻¹ 'K' value (lx)
Expected eggs	95262	Sterility	18262	19.17%	0.80	95262	4.9789
Viable eggs	77000					77000	4.8864
Period I larvae (N ₁)		<i>N. rileyi</i>	10395	13.50%		66605	4.8235
(I and II instars)	77000	Unknown	1540	2.00%	0.68	65056	4.8133
		Rainfall	12065	15.66%		53000	4.7242
Period II larvae (III and IV instars)		<i>N. rileyi</i>	7420	14.00%		45580	4.6587
	53000	Unknown	3710	7.00%	0.77	41870	4.6219
		Birds	870	1.64%		41000	4.6127
Period III larvae (V and VI instars)		<i>N. rileyi</i>	8610	21.00%		32390	4.5104
	41000	Unknown	615	1050%	0.75	31775	4.5020
		Birds	775	1.89%		31000	4.4913
Pupae	31000	Unknown	5270	17.00%	0.83	25730	4.4104
Adults	25730	Sex 50% females	-	-	1.00	25730	
Females x2(N ₂)	25730	Photo period	2730	10.61%	0.89	23000	4.1094
Females	12865	--	--	--		12865	0.3007
Generation Total			94992	99.64			K= 0.8725

Expected eggs = 9751670
 Sterile eggs = 1869395
 Viable eggs = 7882274
 Expected No. of period I larvae = 7882274
 Actual No. of period I larvae (N₂) = 81000
 Generation Survival (SG) N₂/N₁ = 0.3341
 Trend Index = N₂/N₁ = 1.05

Simultaneously with sampling of larvae in the field, a batch of 100 larvae of the pest at each count was collected from the rest of the bulk plot other than sample units and reared in the laboratory. The census on live and dead larvae were recorded daily on each period, upto pupation to observe the extent of parasitism, disease manifestation or other mortality factors. The rainfall was considered as one of the mortality factors if larvae were missing followed by rainfall (Harcourt, 1969). The number of pupae were obtained indirectly from the period III larvae after counting their mortality. One hundred final instar larvae were collected and allowed for pupation in the laboratory to estimate pupal mortality and the percentage emergence of adults and sex ratio. Ten pairs of moths were transferred to oviposition cage and the eggs laid were counted to find out the fecundity. Life tables and budgets were prepared based on the procedures suggested by Harcourt (1969) and Atwal and Bains (1989).

RESULTS AND DISCUSSION

The life tables and budgets for two regular generations of *H. armigera* are presented in Tables 1 and 2.

First Generation

The egg mortality during the first generation was 19.17 per cent which might be due to the sterility factor. The initial population of period I larvae estimated was 77,000. The mortality factors in period I larvae were found to be rainfall (15.66%), *N. rileyi* (13.50%) and unknown factors (2%) accounting for a total mortality of 31.16 per cent, retaining a final population of only 53,000 larvae by the end of period I larvae.

The initial population estimated as period II larvae was 53,000. The total mortality observed was 22.64 per cent, which was contributed by entomogenous fungus *N. rileyi*, unknown factors and predatory birds with 14.00, 7.00 and 1.64 per cent, respectively retaining only 41,000 period II larvae at the end.

The population estimated at the beginning of period III larvae was 41,000. The mortality factors such as *N. rileyi*, birds and unknown factors contributed 21.00, 1.89 and 1.50 per cent mortality, respectively with a total mortality of 24.39 per cent accounting for 10,000 deaths and retained 31,000 larvae for pupation by the end of the larval period. The total pupal mortality of 17.00 per cent was observed due to the unknown factors resulting in failure of 5,270 pupae to yield moths.

A positive trend index of 1.05 ($I > 1$) revealed that the larval population of *H. armigera* (N_t) was on increase in the second generation. Generation survival (SG) was 0.3341 indicating that 33.41 per cent of the population could survive from different mortality factors and completed the life cycle successfully. The different k values recorded for egg, larval, pupal and adult stages were 0.0925, 0.3951, 0.0809 and 0.3007, respectively due to the influence of various mortality factors. Out of the total generation mortality (K) of 0.8725, higher k' values of 0.0891, 0.0554 and 0.0199 were recorded for rainfall, unknown causes and predation by birds during the larval period.

Second Generation

Even though the number of expected period I larvae was as high as 78,82,274 at the

Table - 2 : Life table and Budget for second generation of *H. armigera* on chickpea during rabi 2001-2002.

Stage of the insect (x)	Number alive per ha (ix) ha ⁻¹	Factor responsible for d x f	Number dying during x dx	Mortality per cent 100 qx	Survival rate within Sx $\frac{lx-dx}{lx}$	Numbers/ha mortality after Log Nos./ha (lx)	'K' value
Expected eggs	94724	Sterility	13726	14.49%	0.85	94726	4.9764
Viable eggs	81000					81000	4.9084
Period I larvae (N ₁)		<i>N. rileyi</i>	14580	18.00%		66420	4.8222
(I and II instars)	81000	Unknown	2025	2.50%	0.75	64395	4.8088
		Rainfall	3395	4.19%		61000	4.7853
Period II larvae		<i>N. rileyi</i>	7320	12.00%		53680	4.7298
(III and IV instars)	61000	Unknown	1220	2.00%	0.81	52460	4.7198
		Birds	2460	4.03%		50000	4.6989
Period III larvae		<i>N. rileyi</i>	6250	12.50%		43750	4.6409
(V and VI instars)	50000	Unknown	1750	3.50%	0.78	42000	4.6232
		Birds	3000	6.00%		39000	4.5910
Pupae	39000	Unknown	7800	20.00%	0.80	31200	4.4941
Adults	31200	Sex 50% females	-	-	1.00	31200	0.0969
Females x2(N ₃)	31200		-	-			
Females	15600		-	-			
Generation Total			94726			15600	0.301
							K= 0.7868

Expected eggs	= 13228800	Expected No. of period I larvae	= 11311947
Sterile eggs	= 1916853	Actual No. of period I larvae (N ₂)	= Nil
Viable eggs	= 11311947	Trend Index = N_2/N_1	= -
		Generation Survival (SG) N_3/N_1	= 0.3851

end of the first generation, the actual number of period I larvae observed during the second generation was 81,000 only. The egg mortality owing to sterility or failure to hatch accounted for 14.49 per cent. The mortality factors recorded during the period I larvae were *N. rileyi* (18.00%) birds (4.19%) and unknown factors (2.50%) all contributing to a total mortality of 26.69 per cent retaining a final population of 61,000 at the end of period I larvae which forms the initial cohort of period II larvae. The mortality recorded during the period II larvae due to different factors were *N. rileyi* (12%), birds (4.03%) and unknown factors (2%) contributing to a total mortality of 18.03 per cent which resulted a final population of 50,000 by the end of period II larvae which formed the initial cohort of period III larvae. The mortality factors *N. rileyi* (12.50%), birds (6%) and unknown causes (3.50%) contributed to a total mortality of 22.00 per cent resulting in transformation of only 39,000 period III larvae to pupae. The entire pupal mortality of 20.00 per cent was due to unknown reasons by which 7,800 pupae failed to emerge as moths.

There was no oviposition subsequent to the second generation and hence nil population of period I larvae (N_2) was recorded in third generation. Adult mortality was 100 per cent at the end of second generation. Hence, the trend index $I = N_2/N_1 = \text{zero}$ indicating that the combined action of all the mortality factors successfully reduced *H. armigera* population. The generation survival (SG) was estimated as 0.3851 which indicated that 38.51 per cent of the population could survive from different mortality factors and completed the life cycle successfully. The k' values recorded were 0.068,

0.3174, 0.0969 and 0.301 for egg, larval, pupal and adult stages, respectively. *N. rileyi* recorded the highest k' value of 0.1997 followed by predation by birds and unknown factors with k' values of 0.0766 and 0.0411, respectively.

The higher larval mortality of 48.50 per cent in the first generation as compared to 46.50 per cent in the second generation was probably due to high morning relative humidity, low temperature and good rainfall. Earlier Srinivas (1995) attributed low temperature coupled with rainfall for peak incidence of *N. rileyi* on *H. armigera* larvae on chickpea. Sridhar and Prasad (1996) and Bhanukiran *et al.* (1998) have attributed the low temperature and high morning relative humidity for the high incidence of *N. rileyi* on the larvae of *Spodoptera litura* (Fab). The early instars of the first generation of *H. armigera* on chickpea were washed off and died due to heavy rains received during that period. Detrimental effects of rainfall were earlier reported on the larvae of *H. armigera* (Rao *et al.*, 1990 and Srinivas, 1995). Birds were seen to aggravate larval mortality. Birds in flocks were often observed picking the larvae from chickpea crop during morning and evening hours. High predation of *H. armigera* larvae by birds was earlier reported by Patnaik *et al.* (1995) and Gunatilagaraj (1996) in chickpea crop. The first generation showed a positive trend index ($1.05 > 1$), which suggested that the natural mortality factors operating during this generation were not so effective to cause a decline in the population during the next generation. A negative trend index ($1=0$) was observed for the second generation, since oviposition did not occur subsequent to the second generation. The generation survival

(SG) value of the first generation (0.3341) as against the second generation (0.3851) indicated that the population survival under different mortality factors, was high in the second generation.

Analysis of key mortality factors in both the generations of *H. armigera* showed high K values for *N. rileyi* (0.2307) followed by rainfall (0.0891), predation by birds (0.0766) and the rest by unknown causes. *N. rileyi* was a regularly occurring pathogen during *rabi* season as supported by the evidence provided by Srinivas (1995); Sridhar and Prasad (1996); Bhanukiran *et al.*, (1998). Hence, the fungus can be employed as a potent bioagent on *H. armigera* around Bapatla region.

Among the different phases in the life cycle, period I larvae are more vulnerable to disease infection and other natural enemies. Hence, it may be suggested to avoid insecticidal interference during this phase to encourage the activity of natural enemies. Birds also contributed significantly to the mortality which emphasizes the importance in installation of bird perches in the field to encourage the visit of predatory birds to control the pest population naturally.

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Influence of Weather Parameters on The Occurrence of Major Lepidopteran Pests on Blackgram

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ABSTRACT

A field experiment was conducted at Agricultural College Farm, Bapatla during *rabi* 2001-2002 to determine the occurrence of major lepidopteran pests on blackgram in relation to weather parameters viz., maximum and minimum temperatures, morning and evening relative humidity and sunshine hours. The results indicated positive correlation with morning relative humidity for the spotted pod borer and tobacco caterpillar while maximum temperature, minimum temperature, evening relative humidity and sunshine hours showed negative correlation. Minimum temperature and sunshine hours contributed to the extent of 52.03 and 50.84 per cent out of the total variation of 68.19 and 65.62 per cent by all weather factors in respect of larval incidence of spotted pod borer and tobacco caterpillar.

Key words : Weather Parameters, Occurrence, Lepidopteran, Blackgram

Blackgram, *Vigna mungo* (L.) Hepper is an important pulse crop grown in Andhra Pradesh. It is ravaged by more than 60 species of insects (Lal and Sachan, 1987). The emerging concepts of pest management embodies the idea that knowledge of pest population ecology is essential for appropriate control strategies. Knowledge on occurrence of major lepidopteran pests on blackgram at different growth stages of crop will be of great importance to plan the appropriate control measures. The information on the development of pest in relation to weather parameters will be of immense value to forecast the incidence of the pests in a particular region. Hence, in the light of above situation, the present studies were taken up.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural College Farm, Bapatla during *rabi* 2001-2002, to determine the occurrence of major lepidopteran pests on blackgram in relation to weather parameters. The variety selected for the study was LBG-648. Three bulk plots were

maintained and from each plot 30 plants were selected. The occurrence of major lepidopteran pests during the study were recorded at three days interval starting from the germination of the crop till the end of the season. The data were recorded by taking into account the population of insects per plant on 30 randomly selected plants in each of the three bulk plots depending on the population of insect pests and the species under study.

Meteorological data on maximum and minimum temperatures, morning and evening relative humidities and sunshine hours were recorded from meteorological observatory located at Agricultural College Farm, Bapatla. Simple correlations and multiple linear regression were drawn with the data collected on weather parameters and the occurrence of major lepidopteran pests to obtain correlation coefficients.

RESULTS AND DISCUSSION

The insects that appeared in the major

Table - 1 : Influence of weather parameters on the incidence of *Maruca vitrata* and *Spodoptera litura* on blackgram during rabi 2001-2002.

Date	Number of larvae per 100 plants		Temperature(°C)		Relative humidity (%)		Sunshine (hrs)
			Maximum	Minimum	Morning	Evening	
	<i>M. vitrata</i>	<i>S. litura</i>	(X ₁)	(X ₂)	(X ₃)	(X ₄)	(X ₅)
31 st Dec	8	4	30.80	19.50	83.6	64.6	8.5
3 rd Jan	50	30	29.30	19.20	84.0	73.0	3.9
6 th Jan	127	98	30.73	20.83	92.6	69.6	2.5
9 th Jan	168	139	29.16	18.50	93.0	72.0	4.6
12 th Jan	181	152	30.20	18.10	95.0	72.3	8.2
15 th Jan	190	161	30.26	19.40	96.0	72.0	7.5
19 th Jan	210	181	30.76	18.67	96.3	70.0	6.4
22 nd Jan	243	214	30.62	18.95	95.0	68.0	7.6
25 th Jan	265	236	30.34	17.10	95.3	71.0	5.4
28 th Jan	250	221	32.67	17.43	85.6	65.6	6.9
31 st Jan	224	195	29.33	16.36	90.3	63.3	3.6
3 rd Feb	217	188	30.76	15.50	96.0	68.3	9.5
6 th Feb	217	188	30.80	16.50	97.3	75.6	9.5
9 th Feb	214	185	32.20	18.30	94.0	63.0	8.8
12 th Feb	190	161	33.96	19.43	93.3	67.0	8.0
15 th Feb	113	84	30.96	19.63	97.6	70.6	8.1
19 th Feb	81	52	31.06	17.73	95.3	65.0	9.1
21 st Feb	54	35	32.06	20.46	97.6	74.6	9.7
24 th Feb	45	26	32.86	22.76	95.3	75.6	8.2
27 th Feb	35	23	32.53	21.30	92.3	77.6	8.4
2 nd Mar	13	9	32.93	24.93	79.6	73.6	8.8
5 th Mar	7	5	31.46	19.56	81.0	67.6	9.7

lepidopteran pest status were the spotted pod borer, *Maruca vitrata* (Geyer) and the tobacco caterpillar, *Spodoptera litura* (Fabricius).

The initial occurrence of spotted pod borer and tobacco caterpillar was observed in last week of December and its peak infestation 265.0 and 236.0/100 plants for spotted pod borer and tobacco caterpillar, respectively was observed during second fortnight of January (Table 1). The correlation was negative and significant with minimum temperature, while it was positive and significant with morning relative humidity for spotted pod borer and tobacco caterpillar,

respectively. All the remaining abiotic factors were found to be non significant (Table 2). For spotted pod borer and tobacco caterpillar, January month appeared to be most congenial for the quick multiplication of the pest on account of cool temperature and high humidity. These results are in agreement with the reports of Ezuch (1982), Srivastava *et al.*, (1992), Akhauri *et al.*, (1994) and Lakshmi (2001).

Coefficient of determination for larval incidence of spotted pod borer and tobacco caterpillar was 0.6819 and 0.6562, respectively, which shows that the climatic factors together

Table - 2 : Correlation between *Maruca vitrata*, *Spodoptera litura* incidence in blackgram and weather parameters during rabi 2001-2002

Weather parameter	Number of larvae per 100 plants	
	<i>M. vitrata</i>	<i>S. litura</i>
X ₁ Maximum temperature (°C)	-0.239	-0.227
X ₂ Minimum temperature (°C)	-0.697**	-0.692**
X ₃ Morning relative humidity (%)	0.493*	0.464*
X ₄ Evening relative humidity (%)	-0.304	-0.317
X ₅ Sunshine hours (hr)	-0.253	-0.238

Table - 3 : Multiple linear regression analysis of number of larvae of *Maruca vitrata*, with some weather parameters (larval incidence)

Variable	Regression coefficient	Standard error	t-value
X ₁ Maximum temperature (°C)	25.6668	14.3838	1.7844
X ₂ Minimum temperature (°C)	-29.6369**	9.3041	3.1853**
X ₃ Morning relative humidity (%)	5.2326	2.6917	1.9439
X ₄ Evening relative humidity (%)	-0.6606	3.9120	0.1688
X ₅ Sunshine hours (hr)	-16.8665*	7.3331	2.3000*

Intercept (a) = -403.81 F cal value = 6.861
Percent of variation attributable to the Regression (R²) = 0.6819

Table - 4 : Multiple linear regression analysis of number of larvae of *Spodoptera litura*, with some weather parameters (larval incidence)

Variable	Regression coefficient	Standard error	t-value
X ₁ Maximum temperature (°C)	22.9240	13.7058	1.6725
X ₂ Minimum temperature (°C)	-26.6276**	8.8333	3.0144**
X ₃ Morning relative humidity (%)	4.5153	2.6016	1.7355
X ₄ Evening relative humidity (%)	-1.2522	3.7829	0.3310
X ₅ Sunshine hours (hr)	-14.4473**	6.9782	2.1703**

Intercept (a) = -309.54 F cal value = 6.108
Percent of variation attributable to the Regression (R²) = 0.6562

** Significant at 1% level

* Significant at 5% level

were able to explain the variation in the larval incidence of spotted pod borer and tobacco caterpillar to the extent of 68.19 and 65.62 out of 100 respectively. Out of all the factors studied, partial regression coefficient for minimum temperature and sunshine hours were found to be significant and negatively correlated contributing to decrease in larval incidence of spotted pod borer and tobacco caterpillar with the increase in minimum temperature and sunshine hours, respectively (Table 3 and 4). These results are in agreement with the reports of Nandihalli *et al.*, (1989), Akhauri *et al.*, (1996) and Ganapathy (1996).

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Effect of Starvation on Larval Mortality and Larval Weight in *Bombyx mori* L. Infected With Nuclear Polyhedrosis Virus During Fourth and Fifth Instars

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ABSTRACT

The fourth and fifth instar larvae showed higher mortality when they were starved for 36 hrs followed by virus infection. The lower mortality was observed in larvae kept for without starvation and virus infection. Similarly the larval weight was also higher in larvae kept for without starvation and virus infection. The lower larval weight was observed in larvae starved for 36 hrs and virus infection.

Key Words : Starvation, Larval mortality, Larval weight, Nuclear Polyhedrosis

The major silkworm diseases in India are grasserie, flacherie, muscardine and pebrine. About 30-40 per cent of cocoon crop is lost due to diseases in India. Among these diseases grasserie disease of silkworm influences to the extent of 15 per cent of yield loss. The grasserie of *Bombyx mori* is known to be caused by a nuclear polyhedrosis virus, *Borrelina bombycis* (Paillot, 1930). Earlier studies reveal that during certain adverse seasons of the year, acute shortage of quality mulberry leaves and exposure to less tolerable physical rearing conditions lead for susceptibility of worms to diseases. Hence to know the impact of food starvation, studies were conducted on grasserie disease of mulberry silkworm, *Bombyx mori* L.

MATERIAL AND METHODS

To study the effect of starvation on the development of NPV, the fourth and fifth instar worms of PM x NB₄ D₂ kept without feed for 0, 12, 24 and 36 hrs immediately after moulting were separately inoculated With BmNPV @ 7 x 10⁹ POB/ml through the first feeding and the

subsequent feeds with normal untreated leaves. Suitable controls too were maintained. Each treatment was replicated three times with 25 worms for each replication. The observations on the larval characters such as percentage of larval mortality, larval weight were recorded.

RESULTS AND DISCUSSION

Larval mortality

The results on the effect of starvation and virus infection on the percentage of larval mortality during fourth and fifth instars was recorded and presented in Table.

The independent effect of virus infection had significant influence on the percentage of larval mortality in fourth instar worms. The highest percentage of mortality (58.906) was observed in virus infected batch compared to control batch where the lowest percentage of mortality (13.841) recorded.

Among the different hours of starvation periods, the highest percentage of mortality (38.014) was observed in both the virus and

without virus infected batches starved for 36 hrs followed by 24hrs (37.301) and 12 hrs (36.027) starvation which were significant with each other. The lower percentage of mortality (34.153) was observed in both virus infected and without virus infected batches kept for without starvation.

The independent effect of virus infection and starvation had significant while their interaction was non significant on percentage of larval mortality in fifth instar silkworms. The highest percentage of mortality (57.868) was observed in virus infected batch and the lowest percentage of mortality (13.169) was observed in control batch. As the starvation period increases, the percentage mortality was also increased.

The maximum percentage of mortality (37.616) was recorded in both the virus infected and without virus infected batches starved for 36 hrs. The lowest percentage of mortality (33.279) was recorded in both virus infected and without virus infected batches kept for without starvation.

Larval weight

Fourth instar larval weight

The effect of virus infection was significant on larval weight of fourth instar. Significantly highest larval weight of 2.528 g was observed in control batch compared to virus infected batch where the larval weight of 2.113 g was observed (Table 1).

The effect of starvation had significant influence on fourth instar larval weight. Significantly higher larval weight (2.753 g) was observed in both virus and without virus infected batches kept for without starvation followed by 12 hrs (2.445 g) and 24 hrs (2.190 g) starvation. The lower larval weight 1.895 g was observed in

both the virus infected and without virus infected batches starved for 36 hrs.

Mature larval weight

The independent effect of virus infection and starvation was significant on the mature larval weight. The mature larval weight of 10.462 g was observed in control batch and the lower larval weight of 9.132 g was observed in virus infected batch. Significantly higher larval weight (10.907 g) was observed in both virus and without virus infected batches kept for without starvation followed by 12 hrs (10.408 g) and 24 hrs (9.410 g) starvation. The lowest larval weight of 8.463 g was observed in both virus and without virus infected batches starved for 36 hrs.

There was a significant interaction effect between starvation and virus infection with respect to mature larval weight. Significantly higher larval weight of 11.733 g was observed in the larvae kept for without starvation and virus infection followed by 6 hrs (10.930 g) starvation. The lower larval weight (7.703 g) was observed for 36 hrs starvation and virus infection followed by 8.900 and 9.223 g observed for 24 hrs starvation, virus infection and 36 hrs starvation, without virus infection, respectively and were significant with each other. The larval weight of 10.040 g was observed for larvae without starvation and with virus infection was statistically similar to that of 9.920 and 9.887 g observed for 24 hrs starvation and without virus infection; 12 hrs starvation and virus infection, respectively.

Hence longer the larvae starved, more susceptible for nuclear polyhedrosis virus. It may be possible that starvation initiated physiological weakening of the larvae and made them more prone to the given dose of virus. These results

Table : Effect of starvation on larval mortality and larval weight in *Bombyx mori* infected with nuclear polyhedrosis during fourth and fifth instars

Starvation (hours)	Larval mortality (%)					
	Fourth instar			Fifth instar		
	With Virus infection	Without virus infection	Mean	With Virus infection	Without virus infection	Mean
0	55.820 (48.773)	12.486 (20.703)	34.153 (34.738)	54.843 (48.480)	11.716 (20.030)	33.279 (34.255)
12	58.393 (52.427)	13.660 (21.720)	36.027 (37.073)	57.020 (49.043)	12.810 (20.987)	34.915 (35.015)
24	60.286 (51.247)	14.316 (22.220)	37.301 (36.733)	58.78 (50.65)	13.746 (21.753)	36.263 (36.009)
36	61.126 (51.410)	14.903 (22.730)	38.014 (37.070)	60.83 (51.260)	14.403 (22.570)	37.616 (36.915)
Mean	58.906 (50.964)	13.841 (21.843)		57.868 (49.095)	13.169 (21.335)	
Larval weight (g)						
0	2.580	2.927	2.753	10.040	11.733	10.907
12	2.117	2.773	2.445	9.887	10.930	10.408
24	1.979	2.400	2.190	8.900	9.920	9.410
36	1.777	2.013	1.895	7.703	9.223	8.463
Mean	2.113	2.528		9.132	10.462	
Larval weight						
Effect of virus	Larval mortality	SEm±	CD	Larval weight	SEm±	CD
	0.5069	1.5378	0.1333	0.1273	0.3860	0.2039
Effect of treatments	SEm±	CD	0.0622	0.1818	0.5459	0.2884
	0.7169	-	0.0879	NS	NS	0.4078
Interaction effect	SEm±	CD	0.0879	0.2545	0.1344	0.4078
	1.0139	NS	0.0879	0.2545	0.1344	0.4078

Figures in parentheses are angular transformed values

NS-Non significant

of the present investigation are tallying with the observation of Janarthanan *et al.*, (1994) who reported that all the larvae in the control group which have never been starved showed no mortality but in other groups, the percentage of mortality increased with the starvation period was increased. Samson *et al.*, (1981) reported that larvae starved more than 12 hrs resulted in more susceptible to incidence of nuclear polyhedrosis virus and also reported that adverse effect on larval growth.

The results of the present investigation are supported by the Satish and Govindan (1988) who reported that starvation itself had adverse effect on the economic traits and it was further aggregated by nuclear polyhedrosis virus infection.

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Determination of Effective Concentrations of Azadirachtin Against Developmental Stages of *Spodoptera litura* (Fab.)*

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ABSTRACT

The effective concentrations (EC) of azadirachtin for 50 and 90 per cent feeding inhibition of third instar larvae of *Spodoptera litura* (Fab.) by leaf dip method were 159.81 ppm and 563.52 ppm, respectively. Ingestion of azadirachtin by larvae was more toxic than its topical application. Hence, the range of EC_{50} values by ingestion method were lower i.e., 17.27 to 18.74 ppm compared to 22.32 to 38.95 ppm in topical method for inhibiting pupation, adult emergence and fecundity. Similarly, the EC_{90} values of these effects by ingestion method were also lower i.e., 58.22 to 69.34 ppm compared to 60.69 to 135.08 ppm in topical method.

Key Words : Effective Concentrations, Developmental stages, *Spodoptera litura*

The Indian neem tree, *Azadirachta indica* (A. juss) has been known as a potential source for insecticidal properties. Extracts from the neem seeds besides being ecofriendly have known insecticidal properties against insect pests of agricultural importance (Schmutterer, 1990). Accordingly several commercial formulations of neem have come into market and are being used at different concentrations of the formulated product by the farmers. The biological activity of azadirachtin, the principal bioactive molecule of neem, has effect on insect feeding, oviposition and on metamorphosis. However, the information with respect to the concentration of azadirachtin required to cause various insecticidal effects is scanty. Hence, the present investigation was carried out to determine the effective concentrations of azadirachtin against developmental stages of *Spodoptera litura* (Fab.) under laboratory conditions during the year 1998-99.

MATERIAL AND METHODS

The test insect, *S.litura* was reared on castor (*Ricinus communis* L.) leaves in the laboratory at room temperature ($27 \pm 2^\circ\text{C}$). The commercial formulation Neemazal 1%E.C.[M/s EID Parry (India) Ltd.] was used to prepare the required concentrations of azadirachtin.

To determine effective concentration for the larval feeding inhibition, a series of azadirachtin concentrations viz., 50, 75, 100, 125, 150, 175 and 200 ppm were prepared by using the commercial formulation following serial dilution technique. The castor leaf discs (40 cm²) were dipped in these emulsions for 30 seconds and allowed to drain the excessive emulsion from the discs surface. Leaf discs treated with acetone served as control. The treated leaf discs were then placed in different jars treatment wise and ten third instar larvae of *S.litura* were transferred

Table - 1 : Effect of azadirachtin as a formulation on pupation, adult emergence, fecundity and feeding of *S.litura*.

Concen- tration (ppm)	Mean Per cent Inhibition						Concen- tration (ppm)	Mean % inhibition of feeding
	pupation		Adult emergence		Fecundity			
	Topical	Ingestion	Topical	Ingestion	Topical	Ingestion		
10	20.00 (26.53) ^a	30.25 (33.35) ^f	26.50 (30.97) ^e	30.25 (33.39) ^f	31.00 (33.84) ^d	31.50 (34.15) ^a	50	16.93 (24.23) ^f
15	23.25 (28.83) ^f	46.00 (42.68) ^a	30.00 (32.23) ^e	43.25 (41.11) ^e	33.00 (34.93) ^d	35.25 (36.44) ^f	75	21.54 (27.64) ^a
20	43.50 (41.40) ^e	51.25 (45.70) ^d	40.00 (39.24) ^d	50.00 (45.00) ^d	34.50 (35.99) ^d	46.00 (42.72) ^e	100	24.61 (29.73) ^a
25	56.00 (48.44) ^d	63.00 (52.54) ^c	49.25 (44.60) ^c	52.50 (46.45) ^d	38.25 (38.21) ^c	56.50 (48.73) ^d	125	36.15 (36.94) ^d
30	66.25 (54.47) ^c	71.50 (57.74) ^b	50.00 (45.00) ^c	63.50 (52.84) ^c	46.25 (42.87) ^b	67.50 (55.27) ^c	150	43.07 (41.03) ^c
35	70.00 (56.79) ^b	75.00 (60.03) ^b	56.50 (48.75) ^b	77.50 (61.74) ^b	49.50 (44.73) ^b	78.00 (62.03) ^b	175	56.91 (48.97) ^d
40	80.00 (63.44) ^a	86.50 (68.49) ^a	70.00 (56.79) ^a	82.50 (65.32) ^a	53.50 (47.01) ^a	81.25 (64.37) ^a	200	66.15 (54.43) ^a
Control	0 (2.86) ^h	0 (2.86) ^a	0 (2.86) ^f	0 (2.86) ^a	0 (2.86) ^a	0 (2.86) ^h	Control	0 (2.86) ^a
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.		Sig.
Sem±	3.90	3.99	3.19	3.81	2.71	3.86		3.15
C.D (0.05%)	(1.86)	(2.46)	(1.87)	(2.21)	(2.23)	(1.90)		(2.53)

Figures in the parentheses indicate angular transformation values.

Data in a column followed by a common alphabet were not statistically different at (P=0.05) by Duncan's multiple range test.

into each of the jar. After 24 hours the feeding inhibition of larvae was assessed by recording percentage area of leaf disc left uneaten using leaf area meter.

For determining the effective concentration for pupation inhibition and adult emergence by topical method, a series of concentrations of azadirachtin viz., 10, 15, 20, 25, 30, 35 and 40 ppm were deposited @ 2 µl/larvae on the thoracic region using a microsyringe and later the treated larvae were fed on castor leaves, whereas for ingestion method, the castor leaves were dipped

in the above said concentrations and offered as food for third instar larvae of *S. litura*. After 24 hours the larvae were shifted to untreated castor leaves for further feeding, so as to enable the larvae to enter into pupal stage and to emerge as adults thereafter. Data on inhibition of pupation and adult emergence were recorded.

For assessing the fecundity, four normal looking female adults emerged from the larvae treated by both topical and ingestion methods with 10, 15, 20, 25, 30, 35 and 40 ppm were kept separately in rearing jars along with healthy

Table 2 : Probit analysis of dosage vs inhibition of feeding, pupation, adult emergence and fecundity of third instar larvae of *S. litura* by azadirachtin as a formulation.

Activity	Method of application	b±SE (b=Slope)	Heterogeneity (χ^2)	Regression equation	Effective Concentration (EC)			Fiducial limits	
					EC ₅₀ (ppm)	EC ₉₀ (ppm)	EC ₉₉ (ppm)	EC ₅₀ (ppm)	EC ₉₀ (ppm)
<u>Inhibition of Feeding</u>	Leaf Dip	2.34±0.39	4.48	Y=0.16+2.34X	159.81	563.52		13.59-188.35	33.69-945.97
	Topical	2.95±0.86	0.50	Y=1.02+2.95X	22.32	60.69		17.49-28.49	33.40-110.27
<u>Pupation</u>	Ingestion	2.43±0.82	0.37	Y=1.99+2.43X	17.27	58.22		12.33-24.21	28.80-117.72
	Topical	1.80±0.80	0.45	Y=2.45+1.80X	26.13	135.08		17.54-38.93	27.72-65.15
<u>Adult emergence</u>	Ingestion	2.25±0.81	0.77	Y=2.13+2.25X	18.71	69.34		13.33-26.20	29.53-162.80
	Topical	1.01±0.78	0.24	Y=3.39+1.01X	38.95	72.22		14.00-47.27	31.51-186.88
<u>Fecundity</u>	Ingestion	2.48±0.84	0.86	Y=1.85+2.48X	18.74	61.74		13.83-25.40	29.18-150.64

males to facilitate mating. Fecundity of these female moths was recorded by counting the number of eggs laid by them.

All the experiments were carried out in completely randomized block design with three replications for each treatment. The data pertaining to per cent larval feeding inhibition, inhibition of pupation, adult emergence and fecundity were subjected to arc-sine percentage transformation and analyzed by using analysis of variance (ANOVA) technique (Gomez and Gomez, 1984). The effective concentrations (EC₅₀ and EC₉₀) were calculated following probit analysis (Finney, 1971).

RESULTS AND DISCUSSION

The per cent larval feeding inhibition obtained was significant and dose dependent at all concentrations of azadirachtin tested. The mean per cent reduction in larval feeding was ranged between 16.93 to 66.15 at 50 to 200 ppm of azadirachtin. The effective concentration for 50 per cent inhibition of feeding (EC₅₀) obtained was 159.81 ppm, while the EC₉₀ was 563.52 ppm. The computed heterogeneity (χ^2) 4.48 was less than the table value of 11.1 at 0.05 probability indicating the homogenous response of third instar larvae of *S. litura* towards feeding inhibition effect of azadirachtin (Table 1 and 2). The reduction in food intake by larvae is mainly a gustatory response controlled by sensory organs of mouth parts (Schoonhoven and Jermy, 1977).

Inhibition of pupation due to azadirachtin at 10 to 40 ppm against the larvae of *S. litura* was dose dependent in both topical and ingestion

methods tested. The range of per cent inhibition of pupation recorded was 20 to 80 in topical method while it was 30.25 to 86.50 in ingestion method. The ingestion method gave a lower EC_{50} and EC_{90} values of 17.27 and 58.22 ppm when compared to topical method, which gave 22.32 and 60.69 ppm, respectively for pupation inhibition. The computed heterogeneity (χ^2) values (0.37 and 0.50) for both methods were significantly less than the table value (11.1) at 0.05 probability. This suggests the uniform or homogenous response of *S. litura* larvae to azadirachtin for the effect of pupation inhibition. The neurophysiological reason for inhibition of pupation by azadirachtin is that it acts at the sites of release of prothoracicotropic hormone from corpora cardiaca (Opender Koul, 1993 and Schmutterer, 1990).

Per cent inhibition of adult emergence due to azadirachtin at 10 to 40 ppm was also dose dependent and higher (30.25 to 82.50) in ingestion method compared to topical method (26.50 to 70.00). The effective concentrations for 50 and 90 per cent adult emergence were 18.71 and 69.34 ppm by ingestion method, which were lower than the EC_{50} and EC_{90} values of 26.13 and 135.08 ppm by topical method, thus indicating that digestion of azadirachtin by larvae is more toxic than the topical application thereby resulting in poor emergence of adults. From the value of slope it is evident that for unit increase in dose of azadirachtin, the corresponding increase in inhibition of adult emergence was 2.25 units in ingestion method, which was more than that in topical method (1.80). The poor

emergence of adults from pupae is due to the effect of azadirachtin on the neuroendocrine system altering the ecdysteroid levels interrupting release of eclosion hormone which is a must for adult to emerge from pupa (Schmutterer, 1990).

The range of percent reduction in fecundity was 31.00 to 53.50 in topical method and it was 31.50 to 81.25 in ingestion method. Even the EC_{50} and EC_{90} values of azadirachtin for inhibition of fecundity were lower in ingestion method (18.74 and 61.74) compared to those of topical method (38.95 and 72.22), respectively. The computed heterogeneity (χ^2) values (0.86 and 0.24) were significantly less than the table values for both the methods and thus the results obtained were relevant, suggesting uniform response of *S. litura* larvae to azadirachtin. Reduced rate of egg laying due to azadirachtin treatment is because it systematically delays the synthesis and release of neurosecretions from median neurosecretory cells of brain affecting vitellogenesis (Subrahmanyam and Rao, 1986).

Thus from this investigation it can be inferred that any neem formulation with reference to azadirachtin should be used at a minimum concentration of 565 ppm to result the feeding inhibition effect in 90 per cent of the larval population. Even after the dissipation in the concentration of the azadirachtin it can carry on with other insect growth regulatory effects like inhibition of pupation, adult emergence and fecundity as these effects can result at 60.14 ppm of azadirachtin.

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Life Table Studies of The Tobacco Caterpillar, *Spodoptera litura* (Fab.) Infesting Sunflower

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ABSTRACT

A field and laboratory experiment was carried out at Bapatla to study the life tables of *Spodoptera litura* (Fab.) on sunflower. The age specific life tables revealed that the period II larvae are more vulnerable to natural mortality factors. The highest survival rate was observed in Adult stage. The trend index was 0. The generation survival (SG) of 0.3902 indicated that only 39.02% of the initial population could survive successfully and complete their generation. The number of larvae dead due to *N. rileyi* was maximum contributing higher 'K' value. The highest 'K' value was observed in period II larvae. The population doubling time (DT) was 4.392 days with a potential fecundity of 963.05 eggs.

Key words : Life table, Tobacco caterpillar. Sunflower

Sunflower is now an important oil seed crop in the world. In India it occupies an area of 1.71 m.ha with a production of 0.94 m.t. (Agri. India Green Pages 1999-2001). In Andhra Pradesh it is grown in 0.27 m.ha. with a production of 0.16 m.t. (Statistical Abstract of Andhra Pradesh, 2000).

The production potential of sunflower is greatly reduced by various insect pests, of these most regular lepidopteran pest is tobacco caterpillar, *Spodoptera litura* (Fab.) which is most devastating on sunflower.

Life tables are the most important tools in the pest management and they reveal the most opportune periods and vulnerable stages of the insect species. Series of life tables of the pest, increase the understanding about the pest dynamics and mortality factors.

MATERIAL AND METHODS

A field and laboratory study was carried

out at Bapatla to prepare life table of *Spodoptera litura* (Fab.) on sunflower. A bulk plot of 300 sq.m was raised at Agricultural College Farm, Bapatla during *rabi* 2001-2002. The test variety used was APSH-11. All the agronomic practices were carried out as per the recommendations.

The construction of life table was initiated with the first instar larvae. For the purpose of sampling, larval instars I and II were considered as period 1 larvae, instars III and IV as period 2 larvae and instars V and VI as period 3 larvae.

In the life table, the number of eggs (lx) was estimated indirectly by sampling period 1 larvae and accounting for mortality/sterility in the egg stage. As soon as oviposition was observed on sunflower, a batch of 200 eggs was collected in the field and per cent hatch was recorded to estimate mortality/ sterility of eggs. Laboratory culture was also maintained simultaneously from field collected eggs till the time of emergence of moths with a view to ascertain the stage of the

Table - 1 : Age specific Life table of *S.Litura* on Sunflower during *rabi* 2001 - 2002.

Age interval	Number alive lx	Factor responsible for dx dx f	No. dying during x dx	Morta- lity per cent 100 qx	Survival rate with in x sx	Log log lx no s/ha	'k' value
Expected eggs	272139	Sterility	36379	13.5	0.86	5.4347	
Viable eggs	235400					5.3718	0.0629
Period 1 larvae (N ₁)	235400	<i>N. rileyi</i>	25894	11.00	0.83	5.3211	0.0507
(I & II instars)	209506	Coccinellids	6000	2.54		5.3085	0.0126
	203506	Rainfall	2221	0.94		5.3038	0.0047
	201285	Unknown	5885	2.50		5.2909	0.0129
	195400						0.0809
Period 2 larvae	195400	<i>N. rileyi</i>	33218	17.0	0.68		
III & IV instars	162182	Spiders	6000	3.07		5.2100	0.0809
	156182	Parasitods	13012	6.65		5.1936	0.0164
	143170	Unknown	9770	5.0		5.1558	0.0378
	133400					5.1251	0.0307
							0.1658
Period 3 larvae (V & VI instars)	133400	<i>N. rileyi</i>	11339	8.50	0.78	5.0865	0.0386
	122061	Wasps	8323	6.08		5.0559	0.0306
	113738	Unknown	9338	7.00		5.0187	0.372
	104400						0.1064
Pupae	104400	Unknown	12528	12.0	0.88		
Adults	91872	Sex 50%	...	...	1.00	4.9631	0.0556
	(N ₃)	Females	...	...			
Reproducing Females	45936	...	...	...	1.00	4.6621	0.3010
Normal females x2	91872	Adult mortality	91872	100.00	...	...	...
Generation total			272139				K=0.7726
Expected eggs		=	41572080				
Sterile eggs		=	5612231				
Viable eggs		=	35959849				
Expected No. of period 1 larvae		=	35959849				
Actual No. of period 1 larvae (N ₂)		=	Nil				
Trend index 1 (N ₂ /N ₁)		=	---				
Generation survival SG (N ₃ /N ₁)		=	0.3902				
Sex ratio (male : female)		=	1 : 1				
Average fecundity		=	905 Eggs/female				

Table - 2 : Age specific fecundity table of *S. litura* on sunflower during *rabi* 2001-2002.

Pivotal age in days (x)	Survival of the female at different age interval (lx)	Age schedule for female birth (m:x)	lxmx	x. lxmx	$r_m = 0.15$ $e^{7 \times x} \cdot lxmx$	$r_m = 0.16$ $e^{7 \times m \times} \cdot lxmx$
0-37	0.80	...	Immature stages	...	...	...
38	0.80	..	0.80	30.40	...	...
39	0.80	135 26	108.20	4219.80	340.83	230.46
40	0.80	156 42	125.13	5005.20	339.10	227.73
41	0.80	148 13	118.5	4858.50	276.10	183.67
42	0.80	115 12	92.09	3867.78	185.10	121.55
43	0.74	101 36	75.00	3225.00	129.75	84.00
44	0.68	84.38	57.58	2533.52	85.79	55.27
45	0.58	76.32	44.26	1991.70	56.65	35.85
46	0.54	81.10	43.79	2014.34	48.16	30.21
47	0.42	64.36	27.15	1276.05	25.82	16.01
48	0.40	00.00	00.00	0000.00	00.00	00.00
		Σmx	$\Sigma lxmx$	$\Sigma x.lxmx$	1487.30	984.75
		963.05	692.5	29022.29		

Net reproductive rate = $\Sigma lxmx$ 692.5

Mean duration of generation $T_c = \Sigma lxmx/R_0 = 41.90$ days

Innate capacity for increase in numbers = $r_m = \log_e R_0/T_c$
= 0.1560 females/female/day

Arbitrary r_m (r_a) = 0.15 and 0.16

Corrected $r_m = \Sigma e^{7 \times m \times} lxmx$ 0.1560 females/female/day

Corrected generation time = $T = \frac{\log_e R_0}{r_m} = 41.44$

Finite rate of increase in number (a) = antilog $e^{r_m} = 1.17$ times

Weekly multiplication rate (WMR) = $(e^{r_m})^7 = 3.01$

Doubling time (DT) = $\frac{\log_e 2}{r_m} = 4.392$

Potential fecundity (Pf) = $\Sigma mx = 963.05$

Annual rate of increase (Ari) = $(e^{r_m})^{365} = 1.0329 \times 10^{25}$

insect to be sampled subsequently in the field and to avoid counting of overlapping stages, if any.

Period 1 larvae were sampled five days after egg hatching, period 2 larvae five days after previous count and period 3 larvae six days after sampling of period 2 larvae. In order to record the absolute population of the pest, sample quadrates of 5m x 5m were used. In each count

number of larvae was counted in 10 randomly selected quadrates and population was computed on hectare basis from the average obtained for one quadrate. The observations were recorded daily on these sample units upto pupation. Simultaneously, a batch of 200 larvae was collected at each count from the rest of bulk plot other than the sample units and reared in the laboratory to observe the extent of parasitism,

disease manifestation or other mortality factors.

After pupation the pupae were allowed in the field for three or four days to expose them to natural mortality factors. Then the pupae were brought to the laboratory and observed further till adult emergence. If the adult did not emerge the reason for the failure was recorded.

With this data the age specific fecundity table was constructed according to the format given by Birch (1948).

The adults emerged from the field collected pupae were utilised for the construction of age specific fecundity table in the laboratory. One pair of adults was enclosed in a glass jar and allowed for oviposition. Each jar was covered with black sheet and provided with fresh sunflower leaves and flower buds and a cotton swab dipped in 10 per cent honey to serve as adult food. The sunflower leaves, flower buds and cotton swab were changed daily at the time of egg counting. The number of surviving females and number of eggs laid by each female were recorded daily till the death of the female. The data thus obtained were used for the construction of age specific fecundity table according to the format suggested by Birch (1948) and Poole (1974).

The net reproductive rate ($R_0 = \sum l_x m_x$), mean duration of generation ($T_c = \sum x.l_x m_x / R_0$) and innate capacity for increase (r_c) were calculated. The intrinsic rate of increase (r_m) was calculated by taking two arbitrary trial values of ' r_c ' differing one point in second decimal place and substituted in the $e^{r_m} \times l_x m_x = e^7 = 1096.6$ equation. The trial r_m values on y axis and the summation values on x axis were plotted on the graph. A straight line was drawn connecting

the points of arbitrary ' r_m ' against summation. The point on straight line at which it was intercepted with the vertical line drawn from the established value, 1096.6 from x-axis was considered as accurate value of ' r_m '.

From the r_m value, the corrected generation time ($T = \log_e R_0 / r_m$), finite rate of increase ($\lambda = \text{anti log}_e r_m$), weekly multiplication rate ($\text{WMR} = (e^{r_m})^7$) and doubling time ($\text{DT} = \log_e 2 / r_m$) were obtained by the formulae given by Birch (1948), Southwood (1966) and Atwal & Bains (1974).

RESULTS AND DISCUSSION

The data of age specific life table for *S. litura* were presented in table 1. The life table for *S. litura* on sunflower was constructed by starting with period 1 larvae which included I and II instars with a population of 235400. The total mortality observed during this period was 16.98%. Among the various mortality factors observed, an entomogenous fungus *Nomuraea rileyi* alone caused 11.0 per cent mortality, followed by 2.54, 2.50 and 0.94 per cent mortality by coccinellids, unknown factors and rainfall respectively. The survival rate for period 1 was 0.83 and the number survived by the end of period 1 larvae was 195400.

Regarding period 2 larvae the total mortality recorded during this period was 31.72 per cent of which entomogenous fungus *N. rileyi* alone contributed 17.0 per cent mortality. Parasitoids caused 6.65 per cent mortality followed by unknown factors and spiders contributing 5.00 and 3.07 per cent mortality, respectively. The survival rate during the period was 0.68 and the number of larvae survived by the end of period 2 was 133400.

In case of period 3 larvae once again the major mortality observed during this stage was *N. rileyi*, which contributed 8.5 per cent out of 21.58 per cent of total mortality observed, followed by 7.0 per cent mortality due to unknown factors. Further, wasps caused 6.08 per cent mortality. The survival rate recorded during the period was 0.78 with the final population of 104400.

During pupal stage the mortality due to unknown factors or failure of adults to emerge from pupae was 12.0 per cent and the final population that survived through the pupal stage was 91872.

From the results it is evident that the per cent mortality was higher in period 2 larvae compared to period 1 larvae and period 3 larvae. Period 1 larvae were not observed in the second generation although 35959849 larvae of period 1 were expected at the end of the first generation. Actually nil population of period 1 larvae was recorded. The adult mortality was 100 per cent during the first generation. The trend index (I) was zero, indicating the influence of all the mortality factors in bringing down the population of *S. litura*. Generation survival (SG) of 0.3902 indicated that only 39.02 per cent of the initial population could survive and successfully complete their generation. The average fecundity observed during the generation was 905 eggs per female.

The number of larvae dead due to *N. rileyi* was maximum contributing a high 'k' value of 0.1702 which is in agreement with findings of Bhanukiran *et al.*, (1998) on groundnut crop followed by mortality due to unknown causes, parasitoids, birds, spiders and coccinellids with

'k' values of 0.0808, 0.0378, 0.0306, 0.0164 and 0.0126, respectively. During pupal period, the pupal mortality also contributed significantly to the total 'k' value with a 'k' of 0.05556.

The data regarding the age specific fecundity were presented in Table 2. It was evident from the data that immature stages and pre-oviposition period lasted for 38 days. The first mortality of the female within the cohort occurred on sixth ($lx = 0.74$) day after the emergence of adults and the mortality increased thereafter. The highest egg production ($mx = 156.42$) was observed in the life cycle on 40th day and the lowest ($mx = 64.66$) on 47th day of pivotal age. The egg laying ceased by ninth day after the commencement.

The net reproductive rate (R_0) representing the female birth was 692.5 indicating that the population would multiply 692.5 times at the end of every generation.

The data on intrinsic rate of increase of *S. litura* indicated that the innate capacity for increase in number (r_m) was 0.1578 females per female per day with a finite rate of increase (λ) of 1.170 females per female per day. Thus the population would be able to multiply 3.01 times per week. The doubling time was found to be 4.392 days with a potential fecundity of 963.05 eggs.

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Screening of Accessions/Varieties of Brinjal for Their Degree of Resistance (or) Susceptibility to The Shoot and Fruit borer *Leucinodes orbonalis* Guen.

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ABSTRACT

In assessing the susceptibility or otherwise of brinjal against *Leucinodes orbonalis* Guen., the percentage infestation of the shoot and percentage infestation of the fruit are taken as a criteria. The same parameters were used to evaluate 47 accessions which included few popular released varieties too. Observations made under field conditions on the natural incidence of shoot and fruit borer, showed different susceptibility and resistance among 47 accessions. The damage expression of the resistant Pusa Purple Round and highly susceptible E.P-6 accession formed a basis to measure the comparative resistance. In terms of fruit damage, none of the accessions could escape borer infestation. However, accessions like, Pusa Basant, Pusa Purple Round came under resistant group and accessions like, E.P-35, E.P-46 possessed minimum infestation came under susceptible group.

Key words : Shoot and Fruit borer, Brinjal, Accessions, Resistance, Susceptibility

The shoot and fruit borer (*Leucinodes orbonalis* Guen.,) is an important pest delimiting successful cultivation of brinjal particularly under conditions of high temperature and humidity. It has been reported to cause loss up to 70% in yield. This pest damages egg plant from the nursery to harvest. Young plants are damaged by caterpillars which bore into tender shoots or fruits. To offset these hazards, it has become imminent to seek for built-in protection by way of varietal resistance to the pest species wherever possible. Hence it is planned to screen some of the promising brinjal accessions/ varieties for their resistance to the shoot and fruit borer *L. orbonalis*.

MATERIAL AND METHODS

Forty seven accessions of brinjal were sown in plot of 15m x 1m x 15cm size and 30 days old seedlings were transplanted in ridges and furrows at a spacing of 60cm x 60cm along

the sides of the ridges. 47 treatments were allowed in randomized block design and replicated thrice.

The damaged fruits of brinjal by *L. orbonalis*., showed dark lined entry hole and fresh excreta on them indicating the presence of the larvae. The damage percentage was assessed by taking into account the number of infested fruit and total number of fruits from each plot at each picking till the end of the crop. Depending on the damage percentage the rating was made as below.

<u>Infestation percentage of fruits</u>	<u>Ratings</u>
1-15%	Resistant
15-30%	Susceptible
> 30%	Highly susceptible
<u>Infestation percentage of shoot</u>	<u>Ratings</u>
1-10%	Resistant
10-15%	Moderately resistant
>15%	Susceptible

Developmental studies were conducted in

Table - 1 : Shoot damage due to *L. orbonalis*, in various accessions/varieties of brinjal

S.No.	Acc/variety	% of shoot damage	Scale	Rating
1.	E.P-5	18.22 (25.26)q	5	S
2.	E.P-6	12.82 (20.97)c	3	M.R
3.	E.P-14	19.51 (26.21)w	5	S
4.	E.P-15	16.28 (23.79)f	5	S
5.	E.P-21	22.88 (27.57)D	5	S
6.	E.P-22	26.08 (30.70)O	5	S
7.	E.P-26	16.78 (24.18)i	5	S
8.	E.P-27	18.31 (25.33)s	5	S
9.	E.P-31	21.01 (27.28)B	5	S
10.	E.P-33	20.28 (26.76)Y	5	S
11.	E.P-35	14.85 (22.66)d	5	S
12.	E.P-36	25.06 (30.03)M	5	S
13.	E.P-37	23.88 (29.25)J	5	S
14.	E.P-41	21.24 (27.44)C	5	S
15.	E.P-46	28.01 (31.95)S	5	S
16.	E.P-54	27.85 (31.85)R	5	S
17.	E.P-57	22.38 (28.23)F	5	S
18.	E.P-69	20.85 (27.23)A	5	S
19.	E.P-77	16.24 (23.76)e	5	S
20.	E.P-93	18.95 (25.80)t	5	S
21.	E.P-99	19.34 (26.08)u	5	S
22.	E.P-104	22.88 (28.49)G	5	S
23.	E.P-114	27.74 (31.77)Q	5	S
24.	E.P-138	24.81 (29.87)K	5	S
25.	E.P-140	23.27 (28.84)H	5	S
26.	E.P-167	17.34 (24.60)m	5	S
27.	E.P-174	16.88 (24.25)j	5	S
28.	E.P-176	22.07(28.01)E	5	S
29.	E.P-178	17.87(24.99)n	5	S
30.	V ₁₀	24.86(29.90)L	5	S
31.	V ₄₅	23.84(29.22)I	5	S
32.	Pusa Purple Round	7.26(15.60)b	1	R
33.	K.S-326	18.28(25.31)r	5	S
34.	Pusa Basant	5.29(13.29)a	1	R
35.	AUB-123	16.95(24.30)k	5	S
36.	DBR-19	19.47(26.18)v	5	S
37.	DBR-31	18.05(25.13)p	5	S
38.	J.C-2	17.47(25.04)o	5	S
39.	Double Fruited Variety	16.58(24.02)g	5	S
40.	ARBH-216	25.24(30.15)N	5	S
41.	Banaras Gaint	23.28(28.84)H	5	S
42.	PY-141	20.48(26.90)z	5	S
43.	TS-000123	17.06(24.39)l	5	S
44.	PY-122	27.00(31.30)p	5	S
45.	DBSR-31	18.27(25.30)r	5	S
46.	ARBH-242	19.84(26.44)x	5	S
47.	B.P-33	16.61(24.05)h	5	S
	C.D (P=0.05)	1.1097		
	S.E	0.3956		

Values are mean of three replications

Figures in parenthesis are arcsin transformed values

Values followed by same alphabet do not differ significantly by DMRT

the laboratory on each variety selected from field screening as per methods described by Sah *et al.*, (1995). The experiments were conducted under controlled conditions of temperature viz., 27±2 C and relative humidity (75-85 per cent) in the laboratory. The highly susceptible accession E.P-6 remained as a susceptible check. Each treatment was replicated four times with five larvae in each.

Observations on the length of the larvae were taken on ten days after hatching when it has almost reached a full-grown stage. Three larvae were randomly selected from each replication and length of the each larvae was measured on a centimetre scale from which the average length was worked out. The larvae taken for measurement of length on the tenth day after hatching were weighed using an electronic balance and average weight was worked out for 3 larvae from each replication and their weight was recorded.

Newly formed pupae were used for observation. Three pupae were selected at random from each replication and their length was recorded by using a centimetre scale from which the average pupal length was worked out. The pupae selected for measurement of the length were weighed using an electronic balance and average was worked out for three pupae from each replication. The time taken by larvae from hatching till pupation was recorded in each replication and the average period was calculated. The time in between pupation of the larvae and emergence of moths was recorded and average pupal period was calculated. The total number of moths emerged from pupae were counted in each replication and percentage of emergence was worked out.

From the above observations, Growth

Index (G.I) for different accessions were calculated by using the following formula.

$$G.I = \frac{\text{Pupal percentage}}{\text{Larval period in days}}$$

RESULTS AND DISCUSSION

The results pertaining to the observed percentage damage of shoot with their arcsin transformed values for 47 accessions/varieties are presented in Table 1.

In terms of fruit damage, none of the accessions could escape borer infestation. However accessions like Pusa Basant, Pusa Purple Round came under resistant group and accession like E.P-35, E.P-46 possessed minimum infestation came under susceptible group. The results pertaining to the observed percentage fruit damage with their arcsin transformed values for 47 brinjal accessions/varieties are presented in the Table 2.

From the results, it was observed that the female moths preferred the highly susceptible E.P-6 accessions for laying eggs. The same result was earlier reported by Panda and Das (1975). More number of eggs were laid on E.P-6 than on other resistant and susceptible entries, possibly due to abundant hairiness on the leaves. The same results was reported by Madhavan Nair and Abraham (1998).

Larvae when reared on different plants of accessions/varieties showed significant difference in their larval length Table 3. Larvae attained a maximum length (2cm) when reared on E.P-6 and minimum (1.10cm) on Pusa Purple Round. The maximum reduction was obtained on Pusa Purple Round (45%) followed by Pusa

Table - 2 : Percentage fruit damage in various accessions/varieties for tested against *L.orbonalis*

S.No.	Acc/variety	% fruit infestation	Scale	Rating
1.	E.P-5	49.87 (44.92)J	7	H.S
2.	E.P-6	60.1 (50.82)T	7	H.S
3.	E.P-14	48.62 (44.21)H	7	H.S
4.	E.P-15	42.25 (40.54)u	7	H.S
5.	E.P-21	52.59 (46.48)N	7	H.S
6.	E.P-22	45.23 (42.25)B	7	H.S
7.	E.P-26	55.29 (48.04)S	7	H.S
8.	E.P-27	40.10 (36.61)m	7	H.S
9.	E.P-31	53.11 (46.77)P	7	H.S
10.	E.P-33	25.13 (30.08)h	5	S
11.	E.P-35	20.69 (27.05)e	5	S
12.	E.P-36	50.25 (45.14)k	7	H.S
13.	E.P-37	44.48 (41.83)A	7	H.S
14.	E.P-41	22.34 (28.19)f	5	S
15.	E.P-46	16.12 (23.67)d	5	S
16.	E.P-54	43.24 (41.11)w	7	H.S
17.	E.P-57	45.53 (42.43)c	7	H.S
18.	E.P-69	51.24 (45.68)l	7	H.S
19.	E.P-77	23.48 (28.97)g	5	S
20.	E.P-93	46.30 (42.87)E	7	H.S
21.	E.P-99	48.16 (43.93)G	7	H.S
22.	E.P-104	53.78 (47.17)Q	7	H.S
23.	E.P-114	40.23 (39.36)r	7	H.S
24.	E.P-138	44.10 (41.61)Z	7	H.S
25.	E.P-140	49.05 (44.45)l	7	H.S
26.	E.P-167	27.12 (31.37)j	5	S
27.	E.P-174	39.09 (38.69)o	7	H.S
28.	E.P-176	46.15 (42.79)D	7	H.S
29.	E.P-178	51.25 (45.71)M	7	H.S
30.	V ₁₀	25.29 (30.18)l	5	S
31.	V ₄₅	43.45 (41.23)x	7	H.S
32.	Pusa Purple Round	8.42 (16.86)b	3	R
33.	K.S-326	41.49 (40.09)t	7	H.S
34.	Pusa Basant	10.63 (19.02)c	3	R
35.	AUB-123	25.55 (30.39)a	5	S
36.	DBR-19	44.49 (41.83)A	7	H.S
37.	DBR-31	47.78 (43.72)F	5	S
38.	J.C-2	28.31 (32.13)K	5	S
39.	Double Fruited Variety	43.89 (41.48)y	7	H.S
40.	ARBH-216	52.95 (46.69)O	7	H.S
41.	Banaras Gaint	39.49 (38.92)p	7	H.S
42.	PY-141	54.86 (47.78)R	7	H.S
43.	TS-000123	28.88 (32.50)l	5	S
44.	PY-122	40.83 (39.71)s	7	H.S
45.	DBSR-31	57.65 (40.90)V	7	H.S
46.	ARBH-242	38.29 (38.22)n	7	H.S
47.	B.P-33	39.79 (39.10)q	7	H.S
	C.D(P=0.05)	3.1109		
	S.E.	1.110		

Values are mean of three replications

Figures in parenthesis are arcsine transformed values

Values followed by same alphabet do not differ significantly by DMRT

Basant (36%), E.P-46 (24.5%) and E.P-35(10%).

Data on the larval weight of *L. orbonalis*, showed significant variation among accessions/varieties. The relative reduction in the larval weight when compared with larvae reared on E.P-6. The maximum per cent is on Pusa Purple Round (25.50%) followed by Pusa Basant (20.27%), E.P-46 (14.73%).

A relative increase in larval period when compared to the larvae reared on E.P-6 the prolongation of developmental periods in resistant varieties might be due to presence of feeding deterrents like phenolics, glycoalkaloids and others which may inhibit normal feeding behaviour, ultimately leading to non-availability of food to insects to grow normally. Bajaj *et al.*, (1986) suggested that glycoalkaloids in association with phenolic compounds may be conferring resistance to eggplant fruits towards this pest. Data on pupal length of *L. orbonalis*,

showed significant differences among accession/varieties.

Pupal weight significantly varied when reared on different plants of accessions/varieties. The pupal period was maximum on Pusa Purple Round followed by Pusa Basant, E.P-46, E.P-35 and E.P-6 showed significant difference among the accessions/varieties. Growth index of *L. orbonalis*, on the selected lines of brinjal are presented in Table 3. The per cent adult emergence was found to be maximum on E.P-6 and minimum on Pusa Purple Round indicating an overall suitability of E.P-6 as a susceptible accession for normal growth and development of the pest. Influence of different cultivars on the biology revealed that larval period and pupal period longer in resistant varieties than in highly susceptible accession. Decreased larval weight and larval length were noticed in resistant varieties and so with pupal weight and pupal length.

Table - 3 : Development of *L. orbonalis* on different accessions/varieties of brinjal

Acc./variety	Avg. length and wt. of larvae		Avg. larval period (days)	Avg. length and wt. of pupae		Avg. pupal period (days)	Avg. % of moth emergence	Avg. no. of eggs laid by female	Growth Index
	Length (cm)	Weight (mg)		Length (cm)	weight (mg)				
Pusa Purple Round	1.10 ^a	78.20 ^a	16.78 ^a	0.80 ^a	63.57 ^a	12.50 ^a	50.20 (45.11) ^a	20.08 ^a	2.96 ^a
Pusa Basant	1.28 ^d	83.50 ^d	15.56 ^b	0.96 ^d	65.29 ^d	11.26 ^b	63.82 (53.02) ^d	35.09 ^d	4.40 ^d
E.P - 46	1.51 ^c	89.30 ^c	13.35 ^c	1.12 ^c	78.11 ^c	10.79 ^c	70.14 (56.87) ^c	150.09 ^c	6.24 ^c
E.P - 35	1.82 ^b	98.73 ^b	12.27 ^d	1.32 ^b	81.50 ^b	9.59 ^d	89.18 (70.79) ^b	170.05 ^b	9.30 ^b
E.P - 6	2.00 ^a	104.73 ^a	10.78 ^e	1.86 ^a	87.30 ^a	8.29 ^e	91.27 (72.81) ^a	230.04 ^a	10.54 ^a
C.D (P=0.05)	0.0408	2.2630	0.3546	0.0715	1.3517	0.3050	1.9023	11.9861	0.6860
S.E	0.0143	0.7961	0.1248	0.0251	0.4755	0.1073	0.3733	4.2166	0.2413

Values are mean of four replications

Values followed by same alphabets do not differ significantly by DMRT

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Studies on Life Tables of *Maruca vitrata* Geyer on Pigeonpea

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ABSTRACT

A field and laboratory investigation was carried out at Agricultural college, Bapatla to study the life tables of *Maruca vitrata* Geyer on pigeonpea. Studies on life tables revealed that a fungal pathogen, *Mucor hiemalis* was the major mortality factor causing 56.59 and 66.60 per cent mortality of the larvae of *M. vitrata* during the first and second generations of study respectively. The larval parasitoid *Apanteles taragamae* Viereck caused a mortality of 46.00 and 51.32 per cent in the two generations. Dipteran maggots and unknown factors were also responsible for mortality of larvae of *M. vitrata* which accounted for 18.91, 9.51 and 17.08 per cent kill, respectively in both the generations. The pupal mortality was observed due to incomplete pupation (12.5 and 9.52 per cent in first and second generations) and failure of adult emergence (9.52 and 5.26 per cent). However, pupal stage is less vulnerable to natural mortality in the life cycle of *M. vitrata* with high survival rates (0.79 and 0.85 during the two generations). The population growth indices such as net reproductive rate (r_0), intrinsic rate of increase (r_m), finite rate of increase (λ), weekly multiplication rate (WMR), doubling time (DT), were higher in the first generation.

Key words : Lifetable, *Maruca vitrata*

Among the grain legumes, pigeonpea, *Cajanus cajan* (L.) Millsp is one of the major crops in India. In India it is cultivated in 34.62 lakh ha with 19.48 lakh tonnes production. In A.P. it is cultivated in 4.32 lakh ha with 1.7 lakh tonnes production (Statistical Abstracts of Andhra Pradesh, 2000). In spite of the multitudinous uses of the crop, its productivity has been at low in the recent years. More than 200 species of insects live and feed on pigeonpea, though relatively few cause heavy annual yield losses. Among a few serious pests, the spotted pod borer, *Maruca vitrata* (Geyer), causes considerable losses and has attained a major pest status, in Andhra Pradesh.

The information from life tables increase our understanding about the dynamics of an insect population and vulnerable stages to natural mortality, for better management of the pest (Harcourt, 1969). Hence the present studies were aimed to develop life tables of *Maruca vitrata*

on pigeonpea.

MATERIAL AND METHODS

Age Specific Life Table

Pigeonpea crop was raised in an area of 200 m² as bulk and was maintained under natural conditions without applying insecticides. Quadrat sampling units of 2 m x 2 m were fixed at ten randomly selected places for sampling. The pest population was monitored daily and observations were recorded after adult activity was noticed in the field.

A cohort of 100 first instar larvae were identified @ ten in each fixed sampling unit in the field and labelled. The remaining larvae in the sampling unit as well as on the surrounding plants were removed. From this cohort, observations were taken daily regarding the number of survivals in each stage upto pupation and mortality factors including biotic and abiotic factors. Since there was no apparent difference

Table - 1 : Age specific life table of *M.vitrata* on pigeonpea during January, 2003 (I generation)

Stage of Insect	Number living at the beginning	Factor responsible for dx	Number dying during X	dx as a per cent of lx	Survival rate with in X	log lx	K-value.
(X)	(lx)	(dx)	(dx)	(100 qx)	(Sx)		
Larval phase I	100	<i>M.hiemalis</i>	25	25		2.0000	0.1249
	75	<i>A. taragamae</i>	16	21.34		1.8751	0.1042
	59	Dipteran maggots	4	6.78		1.7709	0.0305
	55	Unknown reasons	2	3.63		1.7404	0.0161
	53	Sub total	47	56.75	0.53	1.7243	0.2757
Larval phase II	53	<i>M.hiemalis</i>	10	18.86		1.7242	0.0908
	43	<i>A. taragamae</i>	6	13.95		1.6334	0.0652
	37	Dipteran maggots	3	8.10		1.5682	0.0368
	34	Unknown reasons	2	5.88		1.5314	0.0263
	32	Sub total	21	46.79	0.60	1.5051	0.2191
Larval phase III	32	<i>M.hiemalis</i>	4	12.51		1.5051	0.0580
	28	<i>A. taragamae</i>	3	10.71		1.4471	0.0492
	25	Dipteran maggots	1	4.00		1.3979	0.0177
	24	Sub total	8	27.22	0.75	1.3802	0.1249
Pupa	24	Incomplete pupation	3	12.50		1.3802	0.0580
	21	Failure of adult emergence	2	9.52		1.3222	0.0435
	19	Sub total	5	26.31	0.79	1.2787	-
Adults	19						
Sex ratio (male : female)				= 1.0 : 1.1 (9:10)			
Average fecundity				= 103 eggs / female			
Preoviposition period				= 2 days			
Oviposition period				= 6 days			
Number of females x average fecundity (N_2)				= 972			
Female x 2 (N_3)				= 20			
Trend index (I) N_2 / N_1				= 10.3			
Generation survival (SG) N_3 / N_1				= 0.2			

between first and second instar larvae, they were considered as larval phase I. The third and fourth instar larvae were characterized by a pair of dark spots in each segment which is dirty white and hence, these two instars were considered as larval phase II. The fifth instar larva was creamy white to brownish green and plummy, and it was considered as larval phase III.

After pupation the pupae were allowed in the field for three or four days to expose them to natural mortality factors. Incomplete pupation was considered as one of the pupal mortality factor. Failure of adult emergence was observed as another mortality factor. Thus the age specific life tables were constructed with the following standard columns (Harcourt, 1969).

Table - 2 : Age specific fecundity table of *M. vitrata* on pigeonpea during January, 2003 (I generation)

X	l_x	m_x	$l_x m_x$	$X l_x m_x$	Trial r_m	
					0.07 $e^{7 \cdot r_m} \cdot l_x m_x$	0.09 $e^{7 \cdot r_m} \cdot l_x m_x$
0-24	0.1	-	-	-	-	-
25	0.09	6.75	0.607	15.17	115.67	70.16
26	0.09	20.25	1.822	47.37	323.74	181.26
27	0.09	30.37	2.733	73.79	452.77	261.43
28	0.08	32.63	2.610	73.08	403.16	230.29
29	0.08	16.88	1.350	39.15	194.43	108.86
30	0.07	9.0	0.630	18.19	84.60	46.43
31	0.04	-	-	-	-	-
32	0.00	-	-	-	-	-
		115.87	9.75	267.46	1574.37	898.43

Net Reproductive rate (R_0) = $\Sigma l_x m_x$ = 9.75

Mean duration of generation $T_c = \frac{\Sigma X l_x m_x}{R_0} = 27.43$ days

Approximate value of $r_m = \frac{\log_e R_0}{T} = 0.083$

Accurate value of $r_m = 0.0845$

$$(\Sigma e^{7 \cdot r_m} \cdot l_x m_x = 1096.61)$$

Finite rate of increase (λ) = $\text{antilog}_e r_m = 1.088$

Corrected generation time (T_c) = $\frac{\log_e R_0}{r_m} = 26.94$

Weekly multiplication rate (WMR) = $(e^{r_m})^7 = 1.81$

Doubling time (DT) = $\frac{\log_e 2}{r_m} = 8.55$ days

x = age group or stage of the insect.

l_x = the number living at the beginning of the cohort noted in column 'x'

dx = the number dying within age group stated in column 'x'

dxl = the mortality factor responsible for dx

100 qx = per cent mortality = $\frac{dx}{l_x} \times 100$

S_x = survival rate within age mentioned in 'x' = $\frac{l_x - dx}{l_x}$

Expected eggs in next generation = number of females x fecundity

The number of dead or sterile eggs were counted to arrive the number of viable eggs which

can hatch as young larvae in the next generation.

N_1 = number at the beginning of cohort in column l_x

N_2 = actual number of younger larvae in the next season.

Trend Index (1) = N_2 / N_1 (l_x for young larvae in new season as a ratio of the old)

N_3 = number of females x 2.

Generation Survival (SG) = N_3 / N_1

This gives an Index of population trend without the effects of fecundity and adult mortality (Atwal and Bains, 1974).

Table 3 : Age specific life table of *M.vitrata* on pigeonpea during February, 2003 (II generation)

Stage of Insect	Number living at the beginning	Factor responsible for dx	Number dying during X	dx as a per cent of lx	Survival rate with in X	log lx	K-value.
(X)	(lx)	(dx)	(dx)	(100 qx)	(Sx)		
Larval phase I	100	<i>M.hiemalis</i>	23	23.00		2.0000	0.1136
	77	<i>A. taragamae</i>	17	22.07		1.8864	0.1083
	60	Dipteran maggots	5	8.34		1.7781	0.0378
	55	Unknown reasons	3	5.45		1.7403	0.0243
	52	Sub total	48	58.86	0.52		0.2840
Larval phase II	52	<i>M.hiemalis</i>	14	26.92		1.7160	0.1363
	38	<i>A. taragamae</i>	4	10.52		1.5797	0.0483
	34	Dipteran maggots	1	2.94		1.5314	0.0129
	33	Unknown reasons	3	9.09		1.5185	0.0414
	30	Sub total	22	49.47	0.57	1.4771	0.2389
Larval phase III	30	<i>M.hiemalis</i>	5	16.66		1.4771	0.0792
	25	<i>A. taragamae</i>	2	8.00		1.3979	0.0362
	23	Unknown reasons	2	8.69		1.3617	0.0395
	21	Sub total	9	33.35	0.70	1.3222	0.1549
	21	Incomplete pupation	2	9.52		1.3222	0.0435
Pupa	19	Failure of adult emergence	1	5.26		1.2787	0.0235
	18	Sub total	4	22.22	0.81	1.2552	-
Adults	18						

Sex ratio (male : female)

= 1.0 : 1.0 (9:9)

Average fecundity

= 116 eggs / female

Preoviposition period

= 3 days

Oviposition period

= 6 days

Number of females x average fecundity (N_2)

= 1054

Female x 2 (N_3)

= 18

Trend index (I) N_2 / N_1

= 10.44

Generation survival (SG) N_3 / N_1

= 0.18

The K-value was measured as the difference between successive value for log lx and thus it was the measure of killing power of a mortality factor.

$$K \text{ value} = \log_{10} N - \log_{10} N_s$$

Where N = the number of individuals before the mortality.

N_s = the number of individuals surviving the mortality

Total mortality $K = K_1 + K_2 + \dots + K_n$ (Varley and Gradwell, 1960)

Age Specific Fecundity Table

The adults emerged from the field collected pupae were utilized for the construction of age specific fecundity table in the laboratory. A pair

Table - 4 : Age specific fecundity table of *M.vitrata* on pigeonpea during January, 2003 (II generation)

X	l_x	m_x	$l_x m_x$	$X l_x m_x$	Trial r_m	
					0.07	0.08
					$e^{7-rm_x} \cdot l_x m_x$	$e^{7-rm_x} \cdot l_x m_x$
0-25	0.1	-	-	-	-	-
26	0.09	9.0	0.81	21.06	143.92	110.97
27	0.09	22.0	1.98	53.46	328.03	250.40
28	0.08	28.0	2.24	62.72	346.01	261.51
29	0.07	32.0	2.24	64.96	322.62	241.40
30	0.05	14.0	0.70	21.00	94.00	69.63
31	0.04	11.0	0.44	13.64	55.09	40.40
32	0.00	-	-	-	-	-
33	0.00	-	-	-	-	-
			8.39	236.84	1289.67	974.31

Net Reproductive rate (R_0) = $\sum l_x m_x = 8.39$

Mean duration of generation $T_c = \frac{\sum X l_x m_x}{R_0} = 28.22$ days

Approximate value of $r_m = \frac{\log_e R_0}{T} = 0.075$

Accurate value of $r_m = 0.077$

($\sum e^{7-rm_x} \cdot l_x m_x = 1096.61$)

Finite rate of increase (λ) = $\text{antilog}_e r_m = 1.080$

Corrected generation time (T_c) = $\frac{\log_e R_0}{r_m} = 27.62$

Weekly multiplication rate (WMR) = $(e^{r_m})^7 = 1.714$

Doubling time (DT) = $\frac{\log_e 2}{r_m} = 9.00$ days

of adults were enclosed in a glass jar and allowed for oviposition. Each jar was covered with a black sheet and provided with fresh pigeonpea twigs, leaves and flower buds. Cotton swab with ten per cent honey was provided as diet to adults and preoviposition period was recorded. The pigeonpea leaves, flower buds and cotton swab were changed daily at the time of egg counting. The number of surviving females and number of eggs laid by each female were recorded daily till the death of the female. Data thus obtained

was used for the construction of age specific fecundity table as suggested by Birch (1948) and Poole (1974) with the following columns.

X = Pivotal age of the female

l_x = Number of females as fraction of initial of the cohort (or) number of females alive / number of individuals at the beginning of the cohort.

m_x = Number of female eggs per female per day.

The column l_x and m_x were multiplied to get the total number of female births ($l_x m_x$) in each age interval.

Various population growth indices worked out from the fecundity table are as follows (Atwal and Bains, 1974)

- 1) Net reproductive rate (R_0) = $\sum l_x m_x$.
- 2) Approximate generation time, independent of " r "

$$T = \sum X l_x m_x / \sum l_x m_x$$

- 3) The capacity for increase (r_c) = $\text{Log}_e R_0 / T$.
Where, e = natural log (2.71828)

4) The above " r_c " was an approximate value. A more accurate measure of determining the value of intrinsic rate of increase " r_m " was done by establishing the following relationship.

$$\sum e^{7-r_m} X l_x m_x = e^7 = 1096.6$$

Where, e = natural log = 2.71828 (Atwal and Bains, 1974)

The points of Two trial values of " r_m " differing one point in second decimal place were substituted in the above equation and in each case e^{7-r_m} values were multiplied with $l_x m_x$ values. The trial " r_m " values on Y-axis and summation values on X-axis were plotted on the graph trial " r_m " against summation were connected by a straight line. The point on straight line at which it was intercepted with the vertical line drawn from the established value, 1096.6 from X-axis was considered as accurate intrinsic rate of increase " r_m " value.

From the " r_m " value, the corrected generation time (T_c), finite rate of increase (λ), weekly multiplication rate (WMR) and doubling time (DT) were derived with the following formulae:

- 5) Corrected generation time (T_c) = $\text{Log}_e R_0 / r_m$.
- 6) Finite rate of increase (λ) = $\text{antilog}_e r_m$.
- 7) Weekly multiplication rate (WMR) = $(e^{r_m})^7$

indicating number of births per female per week.

$$8) \text{ Doubling time (DT)} = \log_e 2 / r_m$$

Doubling time (DT) in days indicate the time required for doubling of the population.

RESULTS AND DISCUSSION

The data pertaining to the age specific life tables are presented in table 1 and 3. The fungal pathogen *Mucor hiemalis* Wehmer was found to be the major mortality factor for all the stages of *M. vitrata*. The larval parasitoid *Apanteles taragamae* Viereck was the second major mortality factor for the death of the larvae. Dipteran maggots and unknown reasons were also the factors of mortality. During the pupal stage, incomplete pupation and failure of adult emergence were the causes of mortality. From the cohort of 100 first phase larvae, 19 and 18 adults were the outcome in the first and second generations respectively. Sivaramakrishna (2002) also observed the fungal infection by *M. hiemalis* and the attack by larval parasitoid *A. taragamae* on *M. vitrata* in blackgram.

Among all the stages, the survival rate (S_x) was high (0.75 and 0.70) in pupal stage. The K-Value was highest (0.2757 and 0.2840) in period-I larvae whereas it was low (0.1015 and 0.0670) in case of pupal stage in both the generations.

The sex ratio (male : female) was 1.0 : 1.1 in the first generation whereas it was 1.0 : 1.0 in the second generation. Ganapathy (1996) reported that the sex ratio (male : female) of *M. vitrata* varied between 0.85 : 1.0 to 1.1 on different crops like pigeonpea, greengram, cowpea and blackgram. The average fecundity was 103 and 116 eggs per female in the first and second generations, respectively. The fecundity observed is in agreement with the findings of Ramdasrai (1983) and Ganapathy (1996) who

recorded a mean of 118.33 and 113.28 eggs on pigeonpea, respectively.

Generation survival of *M. vitrata* is 0.2 and 0.18 during I and II generations. This indicates that higher percentage of initial stages successfully completed their generation (20%) during the first generation than in second generation (18%) which is evident by higher K-value in II generation (Total K-value 0.7448) than I generation (Total K-value 0.7213). The trend index i.e the number of young larvae in the new season expressed as ratio of the old was 10.3 and 10.44 during I and II generations which were almost similar though there was a difference in generation survival which may be due to variation in sex ratio as it was higher in I generation (1.0 : 1.1) than the II generation. Higher fecundity was observed in II generation (116 eggs/female) which indirectly gave more number of first instar larvae that led to higher trend index.

Age Specific Fecundity

The population growth indices of *M. vitrata* on pigeonpea revealed that the net reproductive rate (R_0), finite rate of increase and weekly multiplication rate (WMR) were slightly higher in the first generation compared to the second generation. This was due to more number of females (10 in first and 9 in second generation) and better sex ratio (male to female sex ratio was 1.0 : 1.1 in first as against 1.0 : 1.0 in the second generation), that favoured the production of more females in the I generation. The doubling time of population was estimated to be 8.55 days during the first generation, whereas it was 9.00 days in the second generation (Table 2 and 4). The results obtained in the present study are in approximation with the findings of Sivaramakrishna (2002) who studied age specific fecundity of *M. vitrata* on blackgram.

In both the generations, the maximum egg laying was observed on fourth day of oviposition period which suggests spraying of an ovicide on the fourth day after observing adult activity in the field or installing a suitable trap to control the pest would afford better management.

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Efficacy of Certain New Insecticides Against *Spodoptera litura* Fab. Infesting Cabbage

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ABSTRACT

A field study was conducted with thirteen treatments replicated thrice to evaluate the efficacy of certain new insecticides and eco-friendly chemicals and the joint toxicity of the insecticides with *B.t* and novaluron at half of the concentrations against *Spodoptera litura* Fab. on cabbage at the Agricultural College Farm, Bapatla, during *rabi* 2002-2003. Novaluron 0.005% + indoxacarb 0.00725% and indoxacarb 0.0145% were found to be the most effective among all the treatments. The over all mean efficacy of the treatments in the descending order was novaluron 0.005% + indoxacarb 0.00725% > indoxacarb 0.0145% > novaluron 0.005% + spinosad 0.0075% > spinosad 0.015% > *B.t* 0.1% + indoxacarb 0.00725% > *B.t* 0.1% + spinosad 0.0075% > *B.t* 0.1% + novaluron 0.005% > novaluron 0.005% + NSKE 2.5% > NSKE 2.5% + *B.t* 0.1% > novaluron 0.01% > *B.t* 0.2% > NSKE 5%.

Key words : *Spodoptera litura*, Cabbage, Indoxacarb, Spinosad, Novaluron

Cabbage (*Brassica oleracea* var *capitata*) is an important vegetable of almost all parts of the world. Its cultivation is interrupted by the incidence of several pests, viz., *Plutella xylostella* (L), *Spodoptera litura* Fab. and *Crociodolomia binotalis* Zel. Among these *S. litura* is considered as one of the most dreaded pests of cabbage. Several insecticides are being used repeatedly to minimize the pest populations, which lead to undesirable problems such as pesticidal residues, pest resurgence and adverse effects against natural enemies.

Indiscriminate use of insecticides has triggered in the development of resistance and elimination of natural enemies resulting in the failure of control measures through out the world (Talekar and Shelton, 1993). The present study was taken up with a view to delay or prevent the resistance of *S. litura* and also to lower the environmental pollution by using toxic

insecticides at much lower doses in combination with eco-friendly agents viz., Chitin inhibitors and *B.t*.

MATERIAL AND METHODS

The investigation was carried out at Agricultural College Farm, Bapatla during *rabi*, 2002-2003. The experiment was laid out in a randomized block design with thirteen treatments replicated thrice. The seedlings were transplanted at a spacing of 60x45 cm. All the agronomic practices were followed as per the ANGRAU Package of practices. During the crop period two foliar sprays were given at fifteen days interval. In each treatment ten randomly selected plants were tagged for taking observations. Number of larvae on the tagged plants were counted one day before and five, ten and fifteen days after spraying. The mean efficacy of the two sprays was calculated. The per cent reduction of the larval population over control was

Table 1 : Mean efficacy of treatments after two sprayings against *S. litura* on cabbage during rabi 2002-2003.

Treatments	Percent Reduction over control				Mean Efficacy
	1 DAS	5 DAS	10 DAS	15 DAS	
T ₁ Indoxacarb 14.5 SC - 0.0145%	74.36(59.58) ^a	79.47(63.05) ^b	62.55(52.27) ^b	41.66(40.19) ^b	64.51(53.43) ^b
T ₂ Spinosad 45 SC - 0.015%	71.25(57.58) ^b	72.19(58.17) ^d	57.88(49.53) ^c	34.68(36.07) ^d	59.00(50.18) ^d
T ₃ B.t.K (Hatt) - 0.2%	11.65(19.96) ⁱ	52.09(46.19) ^h	19.18(25.97) ⁱ	18.39(25.39) ^h	25.32(30.21) ⁱ
T ₄ Novaluron -- 0.01%	12.34(20.56) ^j	56.43(48.69) ^g	32.02(34.46) ^g	15.91(23.50) ⁱ	29.37(32.68) ⁱ
T ₅ NSKE --5%	16.04(23.60) ^h	25.63(30.41) ⁱ	13.22(21.31) ^j	9.78(18.22) ^k	16.16(23.70) ^k
T ₆ B.t. 0.1% + Indoxacarb 0.00725%	61.52(51.66) ^{ab}	68.61(55.92) ^a	53.06(46.75) ^d	32.85(34.97) ^d	54.01(47.30) ^a
T ₇ B.t. 0.1% + Spinosad 0.0075%	60.22(50.89) ^c	65.74(54.17) ⁱ	50.19(45.11) ^e	30.50(33.52) ^e	51.66(45.93) ⁱ
T ₈ B.t. 0.1% + NSKE 2.5%	38.67(38.45) ^g	45.67(42.51) ⁱ	21.75(27.79) ^h	12.54(20.73) ^a	29.65(32.99) ^d
T ₉ B.t. 0.1% + Novaluron 0.005%	54.56(47.61) ⁱ	58.05(49.63) ^g	46.02(42.71) ⁱ	27.72(31.76) ⁱ	46.57(43.03) ^g
T ₁₀ Novaluron 0.005% + Indoxacarb 0.00725%	68.08(55.60) ^c	81.80(64.75) ^a	68.95(56.13) ^a	44.56(41.87) ^a	65.84(54.23) ^a
T ₁₁ Novaluron 0.005% + Spinosad 0.0075%	63.76(52.99) ^d	76.42(60.95) ^c	61.31(51.53) ^b	37.36(37.67) ^e	59.71(50.59) ^c
T ₁₂ Novaluron 0.005% + NSKE 2.5 %	53.99(47.29) ⁱ	64.76(53.58) ⁱ	33.26(35.22) ^g	22.08(28.02) ^g	43.52(41.27) ^h
T ₁₃ Untreated control	0.00(4.05) ^b	0.00(4.05) ^k	0.00(4.05) ^k	0.00(4.05) ⁱ	0.00(4.05) ⁱ
Ftest	Sig.	Sig.	Sig.	Sig.	Sig.
SED	0.38	0.50	0.36	0.43	0.17
CD (5% level)	1.18	1.56	1.11	1.33	0.37

Figures in paranthesis are angular transformed values

Sig. Significant

DAS-Days after spraying

Numbers followed by same letter in each column are not significantly different.

worked out by using modified Abbot's formulae (Fleming and Ratnakaran, 1985) and the data were subjected to analysis of variance.

RESULTS AND DISCUSSION

The results of the present investigation (Table 1) indicated that at one day after spraying indoxacarb 0.0145% (74.36%) and spinosad 0.015% (71.25%) were found to be the most effective and significantly superior over all the other treatments followed by novaluron 0.005% + indoxacarb 0.00725% (68.08%) and novaluron 0.005% + spinosad 0.0075% (63.76%). At five days after spraying, the treatment novaluron 0.005% + indoxacarb 0.00725% (81.80%) gave the highest reduction of *Spodoptera litura* larval population followed by indoxacarb 0.0145% (79.47%), novaluron 0.005% + spinosad 0.0075% (76.42%) and spinosad 0.015% (72.19%). The next best treatments were *B.t* 0.1% + indoxacarb 0.00725% (68.61%) and *B.t* 0.1% + spinosad 0.0075% (65.74%) being significantly superior over the remaining treatments.

At ten days after spraying, the novaluron 0.005% + indoxacarb 0.00725% (68.95%) has shown significantly the highest performance followed by indoxacarb 0.0145% (62.55%), novaluron 0.005% + spinosad 0.0075% (61.31%) and spinosad 0.015% (57.88%). At fifteen days after spraying also, the treatment novaluron 0.005% + indoxacarb 0.00725% (44.56%) showed the highest degree of efficacy among the treatments followed by indoxacarb 0.0145% (41.66%) and novaluron 0.005% + spinosad 0.0075% (37.36%). The mean effect of the treatments showed that novaluron 0.005 per cent + indoxacarb 0.00725 per cent (65.84%) and indoxacarb 0.0145 per cent (64.51%) were found

to be the most effective and significantly superior over all the other treatments in bringing down the larval population of *S. litura*. The next best treatments were novaluron 0.005% + spinosad 0.0075% (59.71%) and spinosad 0.015% (59.00%) being significantly superior over the remaining treatments. Similarly indoxacarb and spinosad also gave satisfactory control in combination with *B.t*. Among the treatments, *B.t* 0.2 per cent (25.32%) and NSKE 5 per cent (16.16%) were less effective but significantly superior to control.

Indoxacarb, an oxadiazine group is a new insecticide with higher insecticidal property, lower mammalian toxicity and selective action (Bheemanna and Patil, 1999). Spinosad, an unique insecticide developed from soil actinomycetes, *Saccharopolyspora spinosa* is advantageous over the other groups of insecticides because of its safety to ground water and non-target organisms (Thompson *et al.*, 1999). The two insecticides were less effective at one day after spraying but the efficacy increased by the fifth day onwards and continued up to 15 days after spraying. The lower efficacy of indoxacarb and spinosad in combination with novaluron and *B.t* at one day after application was due to the reduced concentrations of the insecticides while novaluron and *B.t* require sometime after application for their action (Mahalakshmi *et al.*, 2002). The high efficacy of the combinations of the insecticides with novaluron at five days after spraying was probably due to the fact that novaluron disrupts chitin deposition and enhances the penetration of insecticides and thus lead to the increased toxicity in combinations (Reddy, 2002). The combination

treatments of *B.t* have shown significant improvement at five days after application which might be due to the virulent infection of *B.t* under stress (Young *et al.*, 1997 and Visalakshmi *et al.*, 2000).

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Biochemical Changes Induced in The Larval Haemolymph of *Spodoptera litura* (Fab.) by *Peribaea orbata* (Wied.)

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ABSTRACT

Biochemical changes occurred in the larvae of *Spodoptera litura* (Fab.) parasitized by a tachinid parasitoid, *Peribaea orbata* (Wied.) indicate significant increase in specific gravity, total haemocyte count, hydrogen ion concentration, total solids, proteins, lipids, sodium, potassium, inorganic phosphate, acid phosphatase activity and significant decrease in quantity of haemolymph, glycogen, uric acid, cholesterol and calcium and insignificant decrease in alkaline phosphatase activity were noted. Pigments in the haemolymph were altered due to parasitization.

Key words : Biochemical changes, haemolymph, *Spodoptera litura* (Fab.), *Peribaea orbata* (Wied.)

The maggots of *Peribaea orbata* (Wied.) (Diptera : Tachinidae) are parasitic and lodged in the haemocoelic cavity of *Spodoptera litura* (Fab.), (Lepidoptera: Noctuidae) larvae and subsist on the haemolymph. Haemolymph is the transport medium for all types of nutrients in the insects and bathes both host and parasitoid. Insect parasitoids deviate the host physiology from normal condition and this has drawn the attention of many investigators (Salt 1963, Dahlman, 1969, Vinson and Iwantsch, 1980; Warren, *et al.*, 1999 and Caijun *et al.*, 2000). Many measurable parameters of lepidopteran larval haemolymph are significantly altered by internal parasites. In consideration of this, it was decided to see whether specific processes associated with parasitism would be reflected in the pattern of haemolymph constituents of parasitized larvae of *S.litura* or not. This information would also give meaning to many observations of biological control experiments. Qualitative and quantitative changes in the haemolymph of host may serve as an index of pathological changes induced by the parasitoid

in the host. Hence different parameters of the haemolymph of parasitized and unparasitized fifth instar larvae of *S.litura* were studied in order to assess the extent of stress caused by the parasitoids *P. orbata* in the host.

MATERIAL AND METHODS

For studying the changes in different parameters, laboratory reared unparasitized fifth instar larvae and experimentally parasitized fifth instar larvae of *S.litura* were used. Since the aim of the present investigation was to assess the maximum damage caused to the tissues of the host, as is evidenced by the changes in the haemolymph, the haemolymph was collected after the emergence of parasitoid larvae by cutting the legs of fifth instar larvae of *S.litura* separately from parasitized and unparasitized Larvae.

For each sample, haemolymph was collected from ten caterpillars. The volume was measured with a micropipette. Specific gravity was estimated by copper sulphate specific gravity

method (Phillip *et al.*, 1945). For the recognition of pigments in the haemolymph absorption spectra method was followed (1:5) (Pawar and Ramakrishnan, 1977) and readings were recorded in the visible range, at an interval of 50nm, starting with 350nm, using 'spectronic-20'. Haemocytes were stained with Methylene blue and counted with double distilled water (1:10) and double electrode pH meter was used. Quantity of total solids was estimated by using the method of Pawar and Ramakrishnan (1977). Protein content was estimated by Biuret method (Silverman *et al.*, 1993), glycogen by the method of Hassid and Abraham (1957), total lipids by the method of Folch *et al.*, (1957), uric acid by Caraway method (Varley, 1976), cholesterol by Zlatkis, Zak and Boyle method (Varley, 1976), sodium and potassium by flame photometer (Henry *et al.*, 1974), calcium by Beron and Bell method (Varley, 1976), inorganic phosphate by Fiske and Subbarow method (Varley, 1976), alkaline and acid phosphatase activity by 4 - amino antipyrine method (Varley, 1976).

RESULTS AND DISCUSSION

The results of the experiments are presented in Table 1

Volume

Volume of the haemolymph is of importance to the efficiency, particularly for transport and translation of pressure from one part of the body to another. As long as there is sufficient haemolymph to circulate, metabolism is not affected (Patton, 1963). The volume of haemolymph of *S.litura* was decreased due to parasitization. Hsiao (1961) reported that parasitoid larvae, *Lydella grisescens* R-D in European cornborer, *Pyrausta nubilalis* (Hubner) fed on haemolymph. Iwantsch (1975) expressed the same opinion in the host *Trichoplusia ni* (Hubner) parasitized by *Hyposoter exiguae* (Viereck). The decrease in haemolymph volume

of parasitized *S.litura* might be due to feeding of maggots.

Specific gravity

It is an index of the physiological state of individual insects. In *S.litura* specific gravity was increased due to parasitization. Similar results were reported in *Heliothis virescens* (F.) parasitized by *Cardiochiles nigriceps* (Viereck) (Vinson and Barras, 1970) and in *Trichoplusia ni* (Hubner) parasitized by *Hyposoter exiguae* (Viereck) (Iwantsch, 1975). As the parasite extracts and utilizes a large amount of protein from the host during its development (Vinson and Barras, 1970), the fat body synthesizes and releases proteins into haemolymph from time to time according to the demands of parasitoid, in turn creating stress on host haemolymph leading to high specific gravity (Vinson and Iwantsch, 1980).

Absorption spectra

Change of haemolymph colour to light yellow was observed due to parasitization. Third instar parasitoid maggots excreted yellow coloured fluid in the host just before their emergence from host. The yellow tinge of the haemocoel might be due to the mixing of excreta of parasitoid with host haemolymph.

Total haemocyte count (THC)

In *S.litura* there was twelve fold increase in haemocyte number due to parasitization. Cai-Jun *et al.*, (2000) reported that haemocyte counts were significantly higher in parasitized host, *Pieris rapae*.

Hydrogen ion concentration (pH)

Significant increase in the haemolymph hydrogen ion concentration was observed in *S.litura* due to parasitization. Parasitization reflects the physiological changes in insects (Vinson and Iwantsch, 1980). Shifts in the normal range of hydrogen ion concentration are indication

of physiological disturbances and failure of vital organs (Patton, 1963).

Total solids

An increase in total solids was recorded due to parasitization in *S. litura*. Correlation between total solids and protein content was observed by Pawar and Ramakrishnan (1977) in *S. litura* due to Nuclear polyhedrosis virus infection. Increase in total solids could be attributed partly due to the increase in protein content of parasitized host larvae *S. litura*.

Proteins

Significant increase in the protein content of the haemolymph was observed in *S. litura* due to parasitization. Increase of protein content due to parasitism was also reported by Dahlman (1969) in *Manduca sexta* (L.) attacked by *Apanteles congregatus* (Say). Vinson and Iwantsch (1980) reported that protein concentration is greater in parasitized larvae. Dahlman (1969) explained that parasite activity, either enzymatic or mechanical, associated with their penetration of the host body wall was responsible for the increase in total soluble protein just prior to parasite emergence.

Glycogen

Decrease in the glycogen content of haemolymph was observed in *S. litura*. Parasitoids place additional stress upon the host and tends to deplete various haemolymph components to a greater extent (Dahlman 1970). Kitano (1974) reported that reduction of sugars is the main reason for the failure of the host larvae (*Pieris* sp.) to encapsulate the eggs of *Apanteles*. Decrease of glycogen in blood may result in defective moulting (Oser, 1976). Absence of moulting in the host *S. litura* might be due to low glycogen content in haemolymph.

Total lipids

Total lipid content was increased due to

parasitization to nearly double the quantity present in unparasitized larvae. Vinson and Barras (1970) reported decrease of lipids in tissues and increase in haemolymph in *Heliothis virescens* (Fab.) attacked by *Cardiochiles nigriceps* (Viereck). Flow of nutrients especially proteins and lipids from fat body to haemolymph aid the nutrition of the developing parasitoids (Vinson, 1972) and in order to meet the excessive demands of the host to trigger its defensive mechanism (Salt, 1963).

Uric acid

It is the most important nitrogenous waste material of insects. The amount of uric acid was decreased due to parasitization. It may be due to the low consumption of diet, with a consequent decrease in the output of the excretory products.

Cholesterol

Significant decrease in cholesterol was observed in *S. litura* due to parasitization. Cholesterol plays an important role in moulting metamorphosis, growth and reproduction of insects because it is the precursor to various steroid hormones like ecdysteroid (moulting hormone) (Patton, 1963; Warren *et al.*, 1999). Haemolymph cholesterol might be actively absorbed by the parasitoid to complete its moulting and growth. In *S. litura* larva, moulting was not observed after parasitization probably due to the decrease of cholesterol.

Sodium

In parasitized *S. litura* the concentration of sodium was increased. When sodium quantity was increased, irritability increased (Boyd, 1953). Irritability might be due to continuous stress caused by internal parasitoids.

Potassium

Potassium content was increased due to parasitization. Potassium ion along with sodium has an effect on muscular irritability (Boyd, 1953).

Table 1 : Biochemical changes in larval haemolymph of *S.litura*

S.No.	Parameter	Number of Samples	Un-parasitized	Parasitized	t-value
1.	Quantity of haemolymph	5	0.85 ± 0.12	0.38 ± 0.07	7.79*
2.	Specific gravity	3	3.78 ± 0.23	4.59 ± 0.23	4.89*
3.	Haemocytes (No/mm ³)	5	121280 ± 30956	1459920 ± 239876	49503200*
4.	pH	3	6.62 ± 0.02	7.7 ± 0.17	106.58*
5.	Total solids (g/100ml)	5	7.76 ± 0.11	8.7 ± 0.12	13.5*
6.	Proteins (mg/100ml)	6	2.11 ± 0.06	2.45 ± 0.04	10.92*
7.	Glycogen (ug/100ml)	3	93.1 ± 8	43.04 ± 6.21	8.57*
8.	Total lipids (mg/100ml)	3	1343.3 ± 9.33	2286.7 ± 120.6	10.74*
9.	Uric Acid (mg/100ml)	3	38.89 ± 1.4	28.85 ± 2.88	5.57*
10.	Cholesterol (mg/100ml)	3	37 ± 3.6	22.33 ± 2.52	5.78*
11.	Sodium (mg/100ml)	3	60.42 ± 9.6	85.4 ± 7.2	3.6*
12.	Potassium (mg/100ml)	3	9.87 ± 2.01	16.8 ± 0.8	5.6*
13.	Calcium (mg/100ml)	3	27.59 ± 1.23	22.51 ± 1.58	4.4*
14.	Inorganic phosphate (mg/100ml)	3	26.9 ± 2.96	37.78 ± 9.27	2.74*
15.	Alkaline phosphatase activity (Bodansky Units/100ml)	3	3.1 ± 0.17	3.03 ± 1.68	0.06
16.	Acid phosphatase activity (Bodansky Units/100ml)	3	11.43 ± 1.53	19.16 ± 2.03	10.3*

* Significant at P = 0.05

Rise in haemolymph potassium indicates pathogenesis in *Bombyx mori* larvae due to bacterial pathogen; *Bacillus thuringiensis* Berliner (Gringorten, 1999).

Calcium

In *S.litura* calcium concentration is decreased due to parasitization. Calcium is essential for efficient nerve conduction and is an important constituent of the haemolymph. Parasites deprive the haemolymph calcium which may disrupt host metabolism (Cheng, 1973). Irritability is lessened by relatively high concentrations of divalent ions (Ca⁺⁺) or by relative depletion of monovalent ions (Na⁺ and K⁺) (Oser, 1976).

Inorganic phosphate

Significant increase of inorganic phosphate was observed in *S.litura* due to parasitization. Gilmour (1961) reported that in insects extra lactic acid production was due to an increase of inorganic phosphate released by the action of ATP ases. Increase of inorganic phosphate in *S.litura* might be due to increased rate of metabolism (Gilmour, 1961) and wound healing process (Oser, 1976).

Alkaline and acid phosphatases

Insignificant decrease in the activity of haemolymph alkaline phosphatase and significant increase in the activity of haemolymph acid phosphatase of parasitized larvae of *S.litura*

was noted in comparison with that of non-parasitized larvae. Decrease of sugar transport ultimately decreases alkaline phosphatase activity. Histolysis produces an increased quantity of acid phosphatase due to high lysosomal activity (Oser, 1976).

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Pathogenicity of *Nomuraea rileyi* (Farlow) Samson to *Spodoptera litura* and *Helicoverpa armigera* in The Laboratory

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ABSTRACT

Median lethal concentration (LC_{50}) and lethal concentration 90 (LC_{90}) values of *Nomuraea rileyi* for each instar of *Spodoptera litura* and *Helicoverpa armigera* and median lethal time (LT_{50}) for each concentration in each instar were calculated by using probit analysis. LC_{50} and LC_{90} 's were positively correlated with age of the larvae, lowest LC_{50} and LC_{90} values were obtained in the case of first instar *Spodoptera litura* (0.33×10^2 and 1.23×10^7 spores ml^{-1} , respectively). The LC_{50} of fifth instar *Helicoverpa armigera* (1.41×10^{10} spores ml^{-1}) was lower than fourth instar (1.57×10^{11} spores ml^{-1}) indicating the higher susceptibility of the former. LT_{50} values were positively correlated with age of the larvae and negatively correlated with concentration of the fungus. The lowest LT_{50} (2.95 days) was recorded with (1×10^7 spores ml^{-1}) in first instar *H. armigera*.

Key words : *N. rileyi*, *S. litura*, *H. armigera*, LC_{50} , LC_{90} , LT_{50} .

Nomuraea rileyi (Farlow) Samson is an imperfect fungal species (Hyphomycetes) belonging to the family moniliaceae and order moniliales. It causes epizootics in caterpillar pests of several crops in different parts of the world. The occurrence of *N. rileyi* under natural conditions in India has been reported on *Helicoverpa armigera*, *Spodoptera litura*, *S. exigua*, *Acontia graillii*, *Diacrisia obliqua*, *Hypocala rostrata*, *Amasacta moorei* etc. Epizootics of *N. rileyi* is being regularly observed in recent years in Guntur district on *H. armigera* and *S. litura* in crops like groundnut, cotton, redgram etc. especially during cooler months (Nov-Feb). The pathogenicity of *N. rileyi* to different instars of *S. litura* and *H. armigera* were tested in terms of LC_{50} , LC_{90} and LT_{50} in the laboratory.

MATERIAL AND METHODS

The cultures of *S. litura* and *H. armigera* were raised from field collected larvae. Routine surface sterilization of rearing containers with 10 per cent formaldehyde was carried out to prevent microbial contamination to the healthy population. *S. litura* larvae were reared throughout on castor (*Ricinus communis* L.) leaves in glass jars of 25 x 15 cm. *Helicoverpa* larvae were reared on artificial diet prepared as per Nagarkatti and Satyaprakash (1974).

Spores of *N. rileyi* were harvested from fresh cadavers with the help of a fine brush into sterile distilled water containing 0.05 per cent Tween 20 and filtered through double layered muslin cloth and were utilized. Suspensions of different spore concentrations were prepared varying from 10^9 ml^{-1} to 10^1 ml^{-1} using serial dilution technique after assessing the number of conidia ml^{-1} in stock solution with the help of an

Improved Neubauer Haemocytometer and compound microscope at a magnification of 440x. Fresh suspensions were prepared at each test.

Different larval instars of *S. litura* and *H. armigera* were dipped for few seconds in conidial suspension of different concentrations (ranging from 10^9 to 10^1 ml⁻¹) to ensure the contact of conidia as this fungus infects only when it comes in contact with the integument. The larval instars were selected immediately after moulting, since newly formed integument is highly susceptible for conidial germination and infection (Fargues and Vey, 1974). For each concentration, 4 replications were maintained with 20 larvae for each replication. Untreated control was maintained simultaneously by spraying with only 0.05 per cent Tween 20 in sterile distilled water. After air drying, the treated larvae were carefully transferred and reared in the containers by providing fresh food daily. The larval mortality recorded at an interval of 24 hr until pupation/death. This experiment was conducted at room temperatures of $26 \pm 2^\circ\text{C}$ and RH's of 91-95%. The per cent larval mortalities were calculated. Median lethal concentration (LC_{50}) and lethal concentration 90 (LC_{90}) for each instar of both the insects and median lethal time (LT_{50}) values for each concentration in each instar were calculated by using probit analysis (Finney, 1977).

RESULTS AND DISCUSSION

The LC_{50} , LC_{90} and LT_{50} values of *N. rileyi* for the different instars of *S. litura* and *H. armigera* were shown in the Tables 1 and 2. In *S. litura*, the lowest LC_{50} and LC_{90} values of 0.33×10^2 and 1.23×10^7 spores ml⁻¹ were recorded in the first instar and the highest (0.45×10^{12} and 1.57×10^{17} spores ml⁻¹) in the fourth instar. The second and third instars recorded the LC_{50} 's of 1.02×10^4 , 0.40×10^6 and LC_{90} 's of 0.77×10^9 , 1.48×10^9

spores ml⁻¹, respectively. From the data it is evident that the LC_{50} and LC_{90} values were directly proportional to the age of larvae. Likely, in *H. armigera* also the LC_{50} and LC_{90} were lowest for the first instar (0.49×10^3 and 0.64×10^8 spores ml⁻¹, respectively) and the highest for the fourth instar (0.22×10^{12} and 0.33×10^{15} spores ml⁻¹, respectively). With increase in age of the larva, the LC_{50} and LC_{90} values increased except the fifth instar which recorded the lower values of LC_{50} and LC_{90} viz., 1.41×10^{10} and 1.34×10^6 spores ml⁻¹, respectively than fourth instar.

For the second and third instars the LC_{50} 's obtained were 0.59×10^4 and 0.55×10^5 spores ml⁻¹, respectively with LC_{90} 's of 0.83×10^8 and 1.46×10^8 spores ml⁻¹ respectively. The data on slope, heterogeneity, regression and fiducial limits of LC_{50} and LC_{90} for four instars of *S. litura* and for all the five instars of *H. armigera* are presented in Table 1. The slope of log concentration probit mortality (lcp) lines increased gradually from first instar with increase in steepness which indicated more tolerance of later instars (Fig. 1 and 2) with an exception that the lcp line of fourth instar *H. armigera* was more steeper than that of fifth instar indicating the higher susceptibility of the latter (Fig. 2)

The results are in line with the following reports. Lu *et al.*, (1998) reported lower LC_{50} values for *N. rileyi* on early instars of *H. armigera* than later instars. Devi (1994) recorded LC_{50} values of *N. rileyi* for second and third instars of *S. litura* as 2.2×10^7 and 2.9×10^7 spores ml⁻¹, respectively. Lower LC_{50} values for *B. bassiana* on early instar and higher values for older larvae of *H. armigera* were observed (Prasad *et al.*, 1990). Rajak *et al.*, (1993) reported that LC_{50} of *B. bassiana* increased with larval age of *Hyblea puer* and *Eutectona machaeralis*. In terms of LC_{50} and LC_{90} , the first instar larvae of *S. litura* were less susceptible than *H. armigera*

Table 2 : Median lethal time (LT⁵⁰) values of *N. rileyi* against different instars of *S. litura* and *H. armigera*

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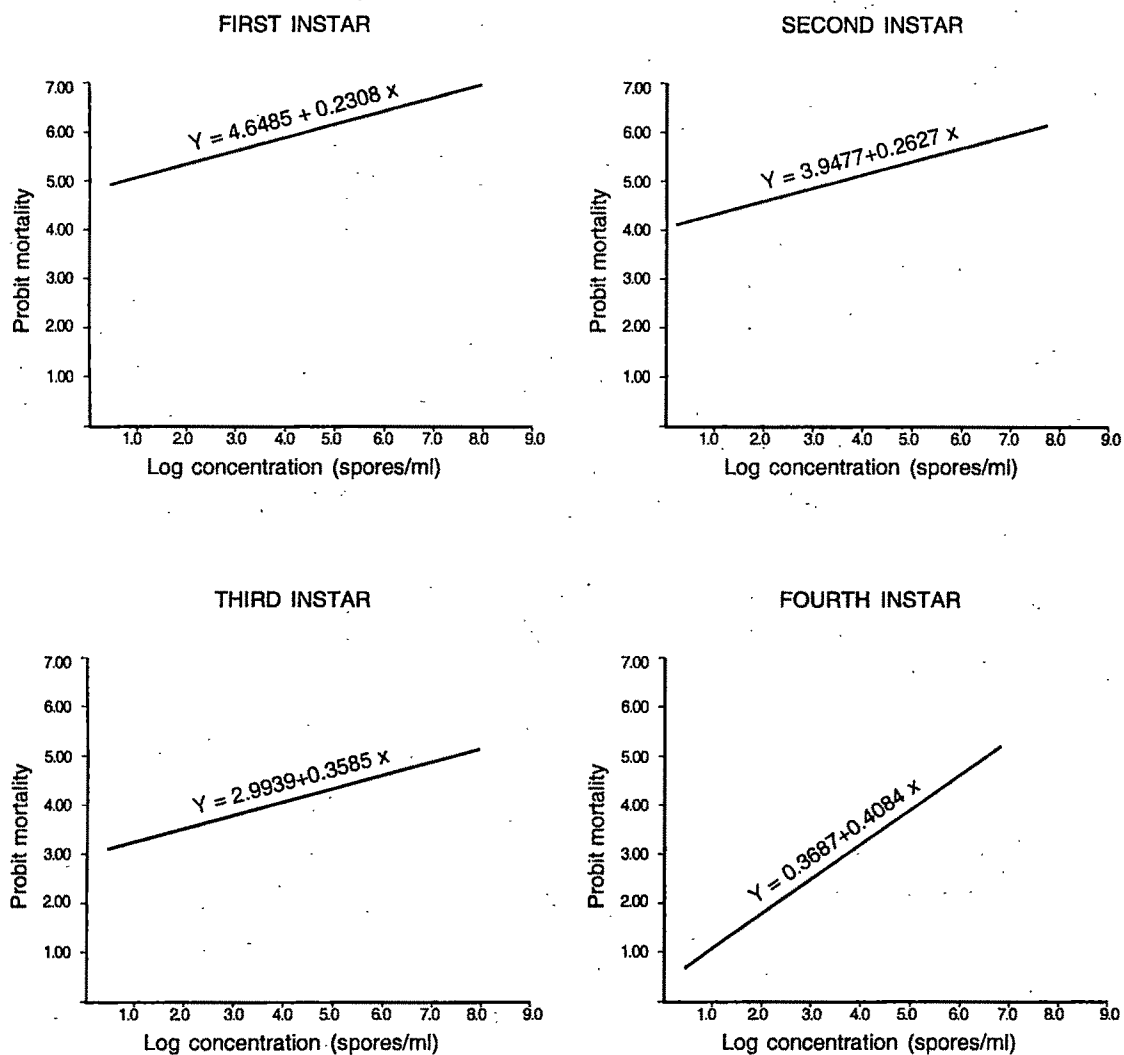


Fig. 1 : Log concentration - Probit Mortality Lines for First, Second, Third and Fourth Instar Larvae of *S. litura* treated with serial dilutions of *N. rileyi*

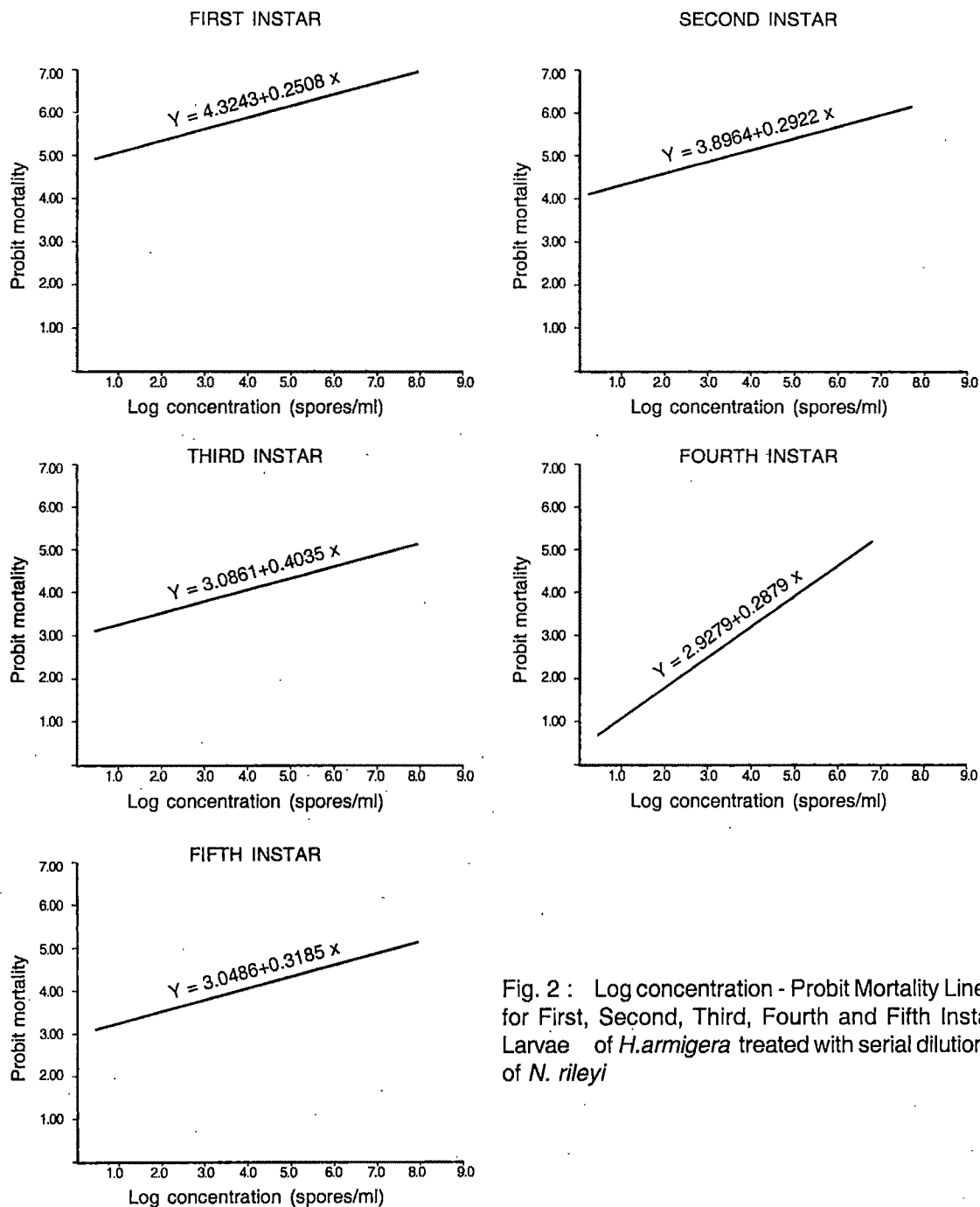


Fig. 2 : Log concentration - Probit Mortality Lines for First, Second, Third, Fourth and Fifth Instar Larvae of *H. armigera* treated with serial dilutions of *N. rileyi*

(Table 1 and 2). However, the fifth instar *H. armigera* recorded lower LC_{50} and LC_{90} values than the fourth instar (Table 2).

Lethal time 50 (LT_{50}) also had positive association with the age of larvae by recording the lowest LT_{50} values of 4.02 days and 2.95 days for the first instar of *S. litura* and *H. armigera* respectively at 1×10^7 spores ml^{-1} (Table 2). LT_{50} of 2.6 days was reported by Maniania and Fargues (1985) when the first instar larvae of *S. frugiperda* were treated with *N. rileyi* @ 3000 conidia mm^{-2} of leaf surface. Lezama *et al.*, (1994) recorded LT_{50} of 3.4 days of *Paecilomyces fumosoroseus* when applied at 1×10^8 spores ml^{-1} against neonate larvae of *S. frugiperda*. The LT_{50} increased with gradual decrease in concentration of *N. rileyi* in all the instars but 1×10^7 spores ml^{-1} concentration recorded lower LT_{50} than 1×10^9 and 1×10^8 (Table 5 and 6). Sivasankaran *et al.*, (1990) obtained similar negative correlation between LT_{50} and concentration of *B. bassiana* when used against second and third instars of *Chilo infuscatellus*. LT_{50} of *N. rileyi* in different instars of *S. litura* and *H. armigera* at 10^8 spores ml^{-1} varied between 4.29 to 9.16 days which is in agreement with the report of Lezama *et al.*, (1994) who observed 4.5 to 9.8 days as LT_{50} when different instars of *S. frugiperda* were treated with *N. rileyi* at 10^8 spores ml^{-1} .

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Biological Studies on Serpentine Leafminer, *Liriomyza trifolii* (Burgess) Attacking French bean

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ABSTRACT

Leaf-mining Diptera, *Liriomyza trifolii* (Burgess) completed its life cycle in 14-21 days with a mean of 18.86 days on French bean. The egg, larva, pre-pupa and pupal stages lasted for 4.85 ± 0.67 , 3.6 ± 0.59 , 0.21 ± 0.17 and 10.20 ± 0.83 days, respectively. The percentage of pupation and adult emergence was 83.0 and 85.7, respectively. The average fecundity was 29 and the maximum number of eggs (15.8 / female) was laid on the second day of captivity. The oviposition period lasted for 6 days. The Sex-ratio was (female : male) 1:0.69. The ratio of oviposition : feeding punctures was 1:6.93.

Key words : French bean, Leafminer, Egg, Larva, Pupa

French bean, *Phaseolus vulgaris* L. is one of the most important leguminous vegetable in India. It is grown for the tender vegetable, shelled green beans and dry beans. The Serpentine leafminer, *Liriomyza trifolii* (Burgess) has attained the status as a new polyphagous pest. Devoid of its natural enemies, this pest multiplied at a faster rate in India on a variety of economically important agricultural and horticultural crops within a short period. Realising the economic importance of the pest, its biology was studied to develop strategies of its management.

MATERIAL AND METHODS

French bean seedlings were grown in plastic glasses (10cm dia.) containing FYM-soil mixture so as to get regular supply of leaves for studying the life history of *L. trifolii* in laboratory. A wooden cage measuring 50 x 50 x 50 cm was taken for maintaining insect culture. To study the duration of individual stage, growth rate of larva, fecundity, feeding and oviposition punctures, 8-9 day-old French bean seedlings raised in plastic glasses were utilized to meet the required purpose.

Stock culture of *L. trifolii* was maintained in the laboratory. Healthy pupae were collected from French bean crop for initiating culture. The adults were sexed as soon as the emergence took place. For providing nutrition to the adult flies, a cotton swab was soaked with 50% honey and squeezed out to take out the excess solution and was fixed inside the wall of the cage.

French bean seedlings were exposed to the adults for 24 hrs for oviposition in the oviposition cage and these seedlings were used to study duration of egg, larva and pupal stages. Glass chimneys were utilized for studying fecundity and feeding punctures. Cotton swab soaked in 50% honey solution was fixed to the wall of the chimney for providing food.

About 20 seedlings were placed inside the oviposition cage for studying the number of instars and duration of each instar of the pest. After a lapse of 24 hrs of exposure one leaf was clipped and fixed in warm 4% formalin at 4 hourly intervals and were kept in screw capped specimen tubes. The process of fixing was continued till the maggots came out of the mines

Table 1 : Duration of different life-stages of *L. trifolii* on French bean under laboratory condition

Developmental stage	No. of insects studied (n)	Range (days)	Duration (days)	
			Mean	± S.D.
Egg	20	4 - 6	4.85	0.6708
Larva (maggot)	20	2 - 4	3.60	0.5908
Pre-puparium	20	0.084-0.22 (2-5.30 hr)	0.213 (5.112 hr)	0.1749
Pupa	20	8 - 11	10.20	0.8335
Total developmental duration	20	14 - 21	18.86	-

Period of study : 04.01.2000 to 01.02.2000

Temp. 22.64 to 26.0°C and R.H. 53.57 to 70.14%

for pupation.

For determining the length and breadth of mines, egg and larval size, staining technique was adopted. Leaf samples of French bean containing mines were warmed for 3 minutes in 0.1% acid fuchsin lactophenol solution and were allowed to cool. Next day all the stained leaves were examined under a stereo-binocular microscope.

RESULTS AND DISCUSSION

Feeding and Oviposition behaviour of adults

The adult females bent their abdomen and made fan-shaped punctures and oviposition punctures and latter were, tubular in shape in which eggs were laid. It was clearly observed in the present findings and also oozing sap from the punctures fed by females. Parrella (1987) recorded that the oozing sap was fed by females from the punctures.

Egg

Eggs were oval-shaped, white and translucent. A black mouth hook (cephalo pharyngeal skeleton) was visible just before hatching of the egg. The egg stage lasted for 4 to 6 days with a mean of 4.85 ± 0.67 days (Table 1). Present findings are in agreement with the findings made by Jagannatha (1994), Dash *et al.*, (1998) and Kandasamy (1999).

Larva (Maggot)

The larvae were apodous with tapering anterior end and a truncated posterior end. They moved through peristaltic action. They were colourless initially but turned yellowish as they matured. The green chlorophyll content inside the gut was clearly visible in the first and second instar maggots under a stereo-binocular microscope. Before emerging out of the mines for pupation, the larvae completed three instars inside the leaf mines. The total larval duration lasted for 2 to 4 days with a mean of 3.60 ± 0.50 days (Table 1). Dash *et al.*, (1998) recorded 5.0 ± 1.2 days larval duration on tomato. Fagoonee and Toory (1984), Dash *et al.*, (1998) and Kandasamy (1999) had confirmed that larval duration was dependent not only on temperature but was influenced by antibiosis factors and therefore, the variation in the present study was but natural.

Special type of fixing and staining technique was adopted to point the exact moulting, duration of each instar. First moulting occurred some time around 16 hrs after eclosion, the second and third moultings 40 and 84 hrs after eclosion, respectively. The growth rate of the larva at each point of time starting from the eclosion till completion of third instar was tracked. It was very clear from the newly hatched larva,

Table 2 : Incremental growth rate of *L. trifolii* maggot in time scale and corresponding mine length on French bean under laboratory condition

Instar	Time scale (hr after eclosion)	Dimension of maggot*		Increase in length over the newly hatched larvae (%)	Mine size (mm)	
		Length	Breadth		Length	Breadth
I	1	0.45254±0.015	0.06732±0.01	-	3.2±0.836	0.10846±0.015
	4	0.5049±0.013	0.0844±0.02	11.57	4.4±0.547	0.1309±0.013
	8	0.54604±0.015	0.11594±0.008	20.66	6.4±0.0894	0.15708±0.01
	12	0.59092±0.01	0.14586±0.008	30.57	8.2±0.836	0.18326±0.008
	16	0.65102±0.004	0.17952±0.01	43.86	11.6±0.547	0.21692±0.01
	20	1.16688±0.01	0.29172±0.01	157.85	19.8±0.1303	0.34408±0.01
	24	1.20428±0.01	0.32538±0.01	166.11	22.2±0.0836	0.36278±0.01
	28	1.2342±0.013	0.35156±0.008	172.72	24.6±0.547	0.38896±0.008
	32	1.27908±0.01	0.38148±0.01	182.64	26.8±0.836	0.41888±0.01
	36	1.3090±0.013	0.38896±0.008	189.25	29.6±0.547	0.42262±0.01
	40	1.31648±0.01	0.41514±0.008	190.90	32.0±1.224	0.45628±0.01
	44	1.33892±0.01	0.44132±0.01	195.87	34.6±0.547	0.47872±0.01
	48	1.69048±0.01	0.50116±0.008	273.55	46.0±1.870	0.53856±0.008
	52	1.7391±0.013	0.50116±0.008	284.29	50.8±0.836	0.53856±0.008
	56	1.8139±0.013	0.51612±0.01	300.82	54.6±1.516	0.55352±0.01
	60	1.8700±0.013	0.51612±0.01	313.22	60.2±1.483	0.55352±0.01
	64	1.94486±0.013	0.51238±0.016	329.76	65.2±1.483	0.54978±0.016
	68	2.0009±0.013	0.53482±0.01	342.14	70.0±1.870	0.57222±0.01
	72	2.06448±0.01	0.53482±0.01	356.19	74.6±1.140	0.57222±0.01
	76	2.10562±0.01	0.54978±0.01	365.28	79.6±1.40	0.58718±0.01
	80	2.15798±0.016	0.56474±0.008	381.68	82.2±1.483	0.60214±0.008
	84	2.22156±0.015	0.54604±0.015	390.90	82.6±1.341	0.58344±0.015

* Mean of 5 individuals

Period of study : 07.02.2000 to 11.02.2000

Temp. 26.0 to 26.18 °C and R. H. 70.14 to 71.28%

the full grown first instar larva attacking French bean leaves had increased by 43.86% (approx. 1.43 times) as compared to the newly hatched larvae. The second and third instar larvae increased by 190.90% (approx. 2.90 times) and 390.90% (approx. 4.90 times), respectively (Table 2). The full grown larvae increased by 8.11

times its width as compared to newly hatched larva.

It was observed that the length of the mine during the first hour of hatching was 3.2mm which increased to 82.6 mm on the 84th hour when the larvae completed the third instar. The length of the mine had a significant and positive correlation

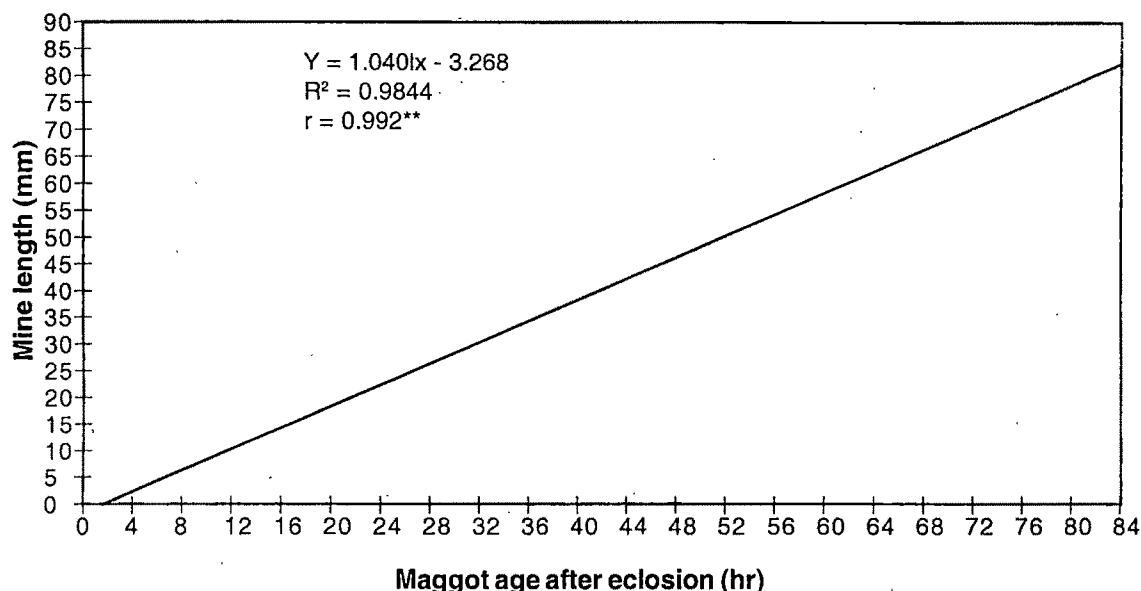


Fig. Length of leaf mine concurrent with maggot age in French bean

with the age of larvae ($r=0.992^{**}$) (Figure).

Pre-puparium

The pre-puparia were yellowish, cylindrical and exhibited wriggling movement. This stage lasted for 2 to 5.30 hr with a mean of 5.11 hr (Table 1). Leibe (1984) recorded that the pre-pupal period varies from 2.67 ± 0.18 to 4.98 ± 0.73 hrs at 35 and 20°C, respectively.

Pupa

The pupa were orange-yellow in colour and coarctate and its colour gradually changed from light brown to dark brown before the emergence of adults. Female pupae were larger in size than males. The pupal stage lasted for 8-11 days with a mean of 10.20 ± 0.83 days (Table 1). Present findings are similar with observations made by Dash *et al.*, (1998) who reported that the pupal duration lasted from 8.8 to 15.4 days basing on the season. The total developmental duration

from egg to adult emergence lasted for 14 to 21 days with a mean of 18.86 days (Table 1). Present findings are in conformity with observations made by Fagoonee and Toory (1984) who observed that the total developmental period of the pest was 19.06 ± 1.06 days.

Fecundity and sex-ratio of adults

It was concluded from the study on French bean that the average fecundity was 29 eggs/female and the oviposition period lasted for 6 days. Maximum number of eggs (15.8 / female) was laid on the second day. The female ratio was 1:0.69 (Table 3).

Oviposition and feeding punctures

Maximum number of feeding punctures (75.8 / female) was made on the first day of captivity which slowly declined to one / female on the seventh day. With regard to oviposition punctures, maximum number of punctures (15.8/

Table 3 : Studies on fecundity of *L. trifolii* on French bean under laboratory condition

Pair No.	Feeding punctures / female								No. of eggs laid / female								Ratio of oviposition to feeding punctures	
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Total	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7		Total
1	135	21	42	12	23	7	0	0	240	5	12	4	3	2	2	0	28	1:8.57
2	109	72	27	23	6	5	0	0	242	2	15	3	5	3	2	0	30	1:8.06
3	25	96	33	24	20	8	3	0	209	7	16	5	2	1	0	0	31	1:6.74
4	90	30	35	10	3	0	0	0	168	5	20	1	1	1	0	0	28	1:6.00
5	20	70	32	14	10	3	2	0	151	3	16	4	3	1	1	0	28	1:5.39
Mean	75.8	57.8	33.8	16.6	12.4	4.5	1.0	0	202.0	4.4	15.8	3.4	2.8	1.6	1.0	0	29.0	1:6.96

Period of study : 22.01.2000 to 29.01.2000

Temp. 25.64 to 26.32°C and R.H. 66.71 to 70.28%

female) were observed on the second day. On the seventh day oviposition completely ceased. It was further observed that the ratio between oviposition and feeding punctures was 1:6.96 (Table 3).

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Studies on Host Range of *Sclerotium rolfsii* Sacc. Isolated From Potato Plants

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ABSTRACT

Studies on host range of *Sclerotium rolfsii* Sacc was conducted in glass house conditions. *S.rolfsii* Sacc. Infected all the tested plants except, sorghum, maize and bajra

Key Words :Host Range, Potato

Wilt of potato caused by *Sclerotium rolfsii* Sacc. is distributed in tropical and subtropical regions of the world and is common in India. So, host range studies was carried out in glass house condition to know their survival of the pathogen in off-season and also in determining the cropping pattern to be followed for the better management of diseases caused by the pathogen.

MATERIAL AND METHODS

The pathogen, *S. rolfsii*, was isolated from collar region of diseased potato plants by tissue isolation and maintained on potato dextrose agar slants.

Mass multiplication of inoculum

In order to get maximum sclerotial bodies for mass multiplication of inoculum sand-corn meal medium was used. The proportion of sand-corn meal medium was 95:5 as described by Abeygunawardhan and Wood (1975). Two hundred grams of sand-corn meal mixture was taken in 500 ml of conical flasks, to which sufficient quantity of distilled water was added and sterilized at 1.4 kg/cm² pressure for 20 minutes. The pure culture of *S. rolfsii* was inoculated to these flasks under aseptic condition and incubated at 27^o±1^oC for 30 days. These

flasks were shaken periodically to get uniform growth. The giant culture so obtained was used for the studying the host range of *S. rolfsii*.

For studying the host range twenty field crops belonging to different families were taken. Well sieved sterilized soil was filled in earthen pots of size 45cmX30cm and one month old *S.rolfsii* giant culture grown on sand-corn meal medium was mixed @ 4 per cent W/W basis. Seeds/seedlings were raised in these pots separately. Moisture was maintained at 25 per cent water holding capacity of the soil. These plants were observed daily for the symptom development.

RESULTS AND DISCUSSION

All the tried plants took infection except sorghum, maize and bajra (Table 1). *S. rolfsii* infected plants showed slight yellowing of leaves and produced the dark brown lesion at collar region. And also presence of white mycelium on the infected portion and soil surface. Sclerotial bodies were found and they were chocolate brown in colour. In addition to potato, the pathogen infect the greengram, lima bean, onion, pepper, water melon, southern pea and sweet potato (Aycock, 1966). During the off season the pathogen survive in the soil by producing the

Table 1 : Host range of *Sclerotium rolfsii* Sacc.

Sl. No.	Name of crop	Scientific name	Family	Infection
1.	Onion	<i>Allium cepa</i>	Alliaceae	+
2.	Garlic	<i>Allium sativum</i>	Alliaceae	+
3.	Groundnut	<i>Arachis hypogaea</i>	Fabaceae	+
4.	Blackgram	<i>Vigna mungo</i>	Fabaceae	+
5.	Greengram	<i>Vigna radiata</i>	Fabaceae	+
6.	Redgram	<i>Cajanus cajan</i>	Fabaceae	+
7.	Pea	<i>Pisum sativum</i>	Fabaceae	+
8.	Cowpea	<i>Vigna unguiculata</i>	Fabaceae	+
9.	Soybean	<i>Glycine max</i>	Fabaceae	+
10.	Okra	<i>Abelmoschus esculentus</i>	Malvaceae	+
11.	Cotton	<i>Gossypium</i> sp.	Malvaceae	+
12.	Jowar	<i>Sorghum bicolor</i>	Poaceae	-
13.	Maize	<i>Zea mays</i>	Poaceae	-
14.	Bajra	<i>Pennisetum americanum</i>	Poaceae	-
15.	Barley	<i>Hordeum vulgare</i>	Poaceae	+
16.	Oat	<i>Avena sativa</i>	Poaceae	+
17.	Brinjal	<i>Solanum melongina</i>	Solanaceae	+
18.	Tomato	<i>Lycopersicum esculentum</i>	Solanaceae	+
19.	Chillies	<i>Capsicum annuum</i>	Solanaceae	+
20.	Tobacco	<i>Nicotiana tabacum</i>	Solanaceae	+

+ : Host

- : Non-host

hard resting bodies (sclerotia) and also infecting the other crops like groundnut, tomato, greengram and onion *etc.* The crops like sorghum, maize and bajra may be used for better management of the diseases caused by *S. rolfsii* through crop rotation.

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In Vitro Efficacy of Fungicides on The Radial Growth of *Trichoderma harzianum* Rifai

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AICRP on Tobacco, RARS, ANGRAU, Nandyal-518 503.

ABSTRACT

Studies on efficacy of different commonly used fungicides on the radial growth of *Trichoderma harzianum*, a native isolate of groundnut rhizosphere revealed that carbendazim completely inhibited the growth of *T.harzianum* at 200, $\mu\text{g ml}^{-1}$ followed by Thiophanate methyl at 400. $\mu\text{g ml}^{-1}$.

Key Words : Fungicides, Radial growth, *Trichoderma harzianum*

Trichoderma spp. as biocontrol agents especially against soil-born pathogens has been taking a prime position in plant disease management. While they are applied to the soil, it would be an added advantage, if they possess resistance to commonly used fungicides, so that they can be integrated, Mancozeb was found to be toxic to *T.harzianum in vitro* (Sharma and Mishra, 1995)

MATERIAL AND METHODS

Efficacy of seven fungicides viz., mancozeb, captan, captafol, thiram, ziram, carbendazim and thiophanate methyl were evaluated at 1, 5, 10, 25, 50, 100, 200, 300, 400 and 500, $\mu\text{g ml}^{-1}$ concentrations. For each treatment 100ml of PDA was taken in 250ml conical flask and autoclaved. Specified concentrations of fungicide was added to this medium and mixed thoroughly by shaking the flask and poured equally into five petriplates, which were treated as five replications.

Mycelial discs of 5mm diameter of the *T.harzianum* were cut with the help of sterilized cork borer and transferred to the centre of each

plate containing poisoned medium. Controls were maintained by placing fungal discs in plates containing untreated (unpoisoned) medium. The diameter of fungal colonies in the treatments was measured when the growth in control plate was full. Per cent inhibition of the organism in different fungicidal treatments over the control was calculated as reported by Patil and Rane, 1982.

RESULTS AND DISCUSSION

The results revealed that the treatments were significantly different in reducing mycelial growth of *T. harzianum*. Out of the seven fungicides tested for their inhibitory or stimulatory effect on the growth of *T.harzianum*, carbendazim completely inhibited the growth at 200, $\mu\text{g ml}^{-1}$ followed by thiophanate methyl at 400, $\mu\text{g ml}^{-1}$ (Table) Thiophanate methyl inhibited the growth to an extent of 33.8 and 65.5 per cent at 150 and 200, $\mu\text{g ml}^{-1}$ respectively. At 300, $\mu\text{g ml}^{-1}$, thiophanate methyl inhibited the growth by 87.1 per cent. At 150 $\mu\text{g ml}^{-1}$, carbendazim inhibited *T. harzianum* about 92.4 per cent. On the other hand the non-systemic fungicides ziram, mancozeb, and thiram were compatible upto 400, 300 and 200, $\mu\text{g ml}^{-1}$ respectively.

Table 1 : *In Vitro* efficacy of fungicides against *T.harzianum*

Treatments	Average colony diameter (mm) of <i>T.harzianum</i> Concentration (g ml ⁻¹)										
	1	5	10	25	50	100	150	200	300	400	500
Carbendazim	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	56.0 (37.8)	23.6 (73.8)	6.8 (92.4)	0.0 (100.0)	0.0 (100.0)	0.0 (100.0)	0.0 (100.0)
Thiophanate methyl	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	86.2 (4.2)	59.6 (33.8)	31.0 (65.6)	11.6 (87.1)	0.0 (100.0)	0.0 (100.0)
Thiram	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	69.6 (12.66)	40.6 (54.9)	35.4 (60.7)
Ziram	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	88.6 (1.96)
Captan	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	84.8 (5.8)	76.4 (5.1)	60.0 (33.3)	31.2 (65.3)
Captafol	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	85.6 (4.9)	81.4 (9.5)	73.0 (18.9)	55.6 (38.2)
Mancozeb	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	82.6 (8.2)	63.4 (29.6)
Control	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)	90.0 (0.0)
Mean	90.0	90.0	90.0	90.0	85.8	81.2	75.8	70.2	63.6	54.3	45.5

Treatments
(F₁)

Concentration
(F₂)

Treatments
(F₁)

Treatments X Concentrations

SEM±

CD 5%

* Mean of five replications

* Figures in parentheses indicates per cent inhibition over control.

1.6

3.1

These results are in agreement with the results of Singh *et al.*, (1995) who reported that at 500 $\mu\text{g ml}^{-1}$, the growth of two isolates of *T. harzianum* was inhibited by 94.5 and 85.0 per cent with captafol and 63 and 49 per cent with dithane- M-45. Fungicides metalaxyl, chlorothionil and captafol showed little inhibition, while thiram was highly inhibitory even at lower concentration (Sharma and Mishra, 1995).

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Biological Management of Dry Root-Rot of Acidlime (*Citrus aurantifolia* Swingle) Caused by *Fusarium solani*

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ABSTRACT

Among 12 isolates of *Trichoderma* evaluated against *Fusarium solani* causing dry root-rot of Acidlime the isolates T2 and T4 were superior over others in inhibition of mycelial growth in dual culture technique under *in-vitro* conditions. The inhibition percentage were significantly superior than the commercially available *T. viride*. Both T2 and T4 isolates reduced the dry root-rot incidence (70.1% and 71.3%) significantly when delivered as soil application in pot trials.

Key words : Acidlime, dry root-rot, *Fusarium solani*, Bio control, *Trichoderma*

Acidlime is an important citrus species widely grown in India. Nearly 20 per cent of the total citrus production comes from this crop. This is affected by number of fungal, bacterial and viral diseases (Gopal *et al.*, 2000). Among fungal diseases dry root-rot is economically important disease caused by *Fusarium solani* (Gopal *et al.*, 2001). The fungus is soil borne and poses great problems in managing the disease. Soil borne diseases are difficult to control by using fungicides. As an alternative to the chemical fungicides in recent years bio-control agents are gaining importance in the management of soil borne plant pathogens. Among all bio-agents a lot of research has been carried out on the *Trichoderma* spp. It is well known that all the isolates of *Trichoderma* are not equally antagonistic towards a species of pathogen. Present study was undertaken to evaluate efficacy of different *Trichoderma* isolates from rhizosphere areas of diseased Acidlime trees to suppress the dry root-rot disease. Twelve isolates of *Trichoderma* were isolated and

screened against *F. solani* under *in-vitro* conditions. Based on the *in-vitro* studies best isolates were selected and tested for their effectiveness under *in-vivo* conditions.

MATERIAL AND METHODS

Rhizosphere soil samples were collected along from around feeder roots from different acidlime gardens of A.P. These samples were used for isolation of *Trichoderma* by using *Trichoderma* specific medium, TSM (Elad and Chet, 1983).

One 'g' of soil was taken and mixed with 9 ml sterile distilled water and stirred well. Serial dilution technique was adopted for isolation of *Trichoderma* from rhizosphere soil samples. A series of dilutions were made upto 10^{-3} dilution; from which dilution 1 ml of soil suspension was taken and added to each petriplate and TSM was incorporated, and the plates were incubated at room temperature. After 3 days *Trichoderma* colonies were picked up from the medium and sub cultured into PDA slants.

Table 1 : *In-vitro* screening of *Trichoderma* isolates against *Fusarium solani*

S.No.	Isolates	Radial growth of <i>F.solani</i> (mm)*	Per cent inhibition over control
1.	T1	25.00	65.2
2.	T2	20.00	72.2
3.	T3	33.00	54.1
4.	T4	20.66	71.3
5.	T5	24.33	66.2
6.	T6	26.66	62.9
7.	T7	23.66	67.1
8.	T8	27.33	62.0
9.	T9	30.33	57.8
10.	T10	25.66	64.3
11.	T11	24.00	66.6
12.	T12	22.66	68.5
13.	Tv	37.33	48.1
14.	Control	72.00	-

SEm(±) 0.43

CD (P=0.05) 1.26

*Mean of three replications

***In-vitro* Screening :** Antagonistic properties of *Trichoderma* isolates were studied through dual culture plate method. Mycelial discs of 9mm diameter cut from the margin of three-day-old cultures of both test pathogen and antagonists were placed opposite to each other on PDA in petriplates. These plates were incubated at 28°C for 72h. The radial growth of *F. solani* in each petriplate was measured and inhibition percentage was calculated.

***In-vivo* studies :** Based on the *in-vitro* studies the best two isolates were selected and their effectiveness was tested in *in-vivo* conditions. Into a six-day-old culture of *Trichoderma* grown on PDA slant, 8ml of sterilized distilled water was poured and shaken vigorously to prepare homogenous spore suspension of T2 and T4 isolates. The 250 ml flasks containing 100g of

sterilized wheat bran sand medium were inoculated with the spore suspension of T2 and T4 separately. These flasks were incubated up to three weeks. This was applied to the sterilized pot soil @ 100g/kg. *Pseudomonas fluorescens*, talc based formulation, was used for comparison @ 20kg of pot soil.

Production of inoculum of *F. solani* :

Sterilized sand maize meal medium in 250ml flask (10g of maize meal, 90g of washed sand and 15ml of distilled water) was inoculated with two discs of 9mm diameter mycelial plug of three day old culture grown on PDA plate. Inoculated flasks were incubated at 28±1°C in a BOD chamber. After three weeks of incubation, the inoculum was mixed with sterilized soil @ 75g / kg pot soil.

Table 2 : Effect of *Trichoderma* isolates (T2 and T4) in controlling dry root-rot of acidlime seedlings caused by *Fusarium solani* in pot culture experiment

S.No.	Treatment	Per cent disease incidence	Per cent decrease over control
1.	<i>Fusarium solani</i> + <i>Trichoderma</i> -2	26.4* (30.92)	70.1
2.	<i>Fusarium solani</i> + <i>Trichoderma</i> -4	25.4 (30.26)	71.3
3.	<i>Fusarium solani</i> + <i>Pseudomonas fluorescens</i>	42.7 (40.80)	51.1
4.	<i>Fusarium solani</i> alone (Control)	88.7 (70.36)	-

SEm(±) 2.33

CD (P=0.05) 7.04

*Mean of five replications

Figures in parentheses are angular transformed values

RESULTS AND DISCUSSION

All the 12 isolates of *Trichoderma* showed their antagonism against *F. solani* in *in-vitro* (Table 1). The isolates T2 and T4 recorded more per cent inhibition (72.2 and 71.3) than others. In other isolates the per cent inhibition ranged from 54.1 to 68.5. Least percentage of inhibition of 54.1 was recorded by the isolate 3. However, the per cent inhibition of 12 isolates was significantly superior to the commercial formulation of *Trichoderma viride*. Such differential response is not a unique observation. Earlier investigations also revealed that all isolates of *Trichoderma* are not equally antagonistic. Isolates differ antagonistic activity against *S. rolfsii* (Elad *et al.*, 1980; Maity and Sen., 1985). Among the 10 isolates of *Trichoderma* only isolates TRC-8 and TRC-28 reduced damping off of lettuce seedlings caused by *Rhizoctonia solani* (Wilson *et al.*, 1988). The isolate Th-58 out of several isolates of *Trichoderma* was the most effective in controlling damping-off of sugar beet caused

by *S. rolfsii* (Lewis and Papavizas, 1987).

Both the T2 and T4 isolates delivered to soil as wheat bran sand formulation reduced the dry root-rot incidence equally and significantly. The per cent reduction was 71.3 and 70.1 with T4 and T2 isolates, respectively, whereas only 51.1 per cent disease reduction was recorded with *Pseudomonas fluorescens* (Table 2). So these two isolates were significantly superior to the *Pseudomonas fluorescens*. Costach *et al.*, (1980) reported that *T. viride* and *T. koningii* when added to soil retarded the symptom development of *Fusarium* wilt of linseed. Wheat bran inoculum preparation when incorporated into soil controlled *Sclerotium rolfsii* more effectively than the simple conidial suspension of the same antagonist incorporated into soil. (Elad *et al.*, 1982). Kousalya and Jeyarajan (1988) also reported that *F. solani* was significantly inhibited by *T. viride* and *Trichoderma* spp.

Based on the present study, these two isolates may be included as a component of IPM in the management of dry root-rot of Acidlime.

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Evaluation of Groundnut Cultivars for Late Leaf Spot Resistance under Rainfed Conditions

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ABSTRACT

Groundnut is the major oil seed crop of India. Groundnut crop suffers from many fungal diseases and among them, late leaf spot is more prevalent and destructive disease caused by *Phaeoisariopsis personata* resulting in economic yield losses. Therefore efforts were diverted to identify resistant cultivar for direct cultivation in endemic areas.

Key Words : Groundnut, Leaf spot, Rainfed conditions

In the present study in order to identify the resistant cultivars, thirteen varieties were screened at Agricultural Research Station, Anantapur against late leaf spot during *kharif*, 1996 - 97 under natural conditions. The varieties were sown in a plot size of 5.0 m x 2.4 m for each variety in randomised block design with 30 cm x 10 cm spacing, with three replications. The late leaf spot incidence observations were recorded on per cent rating scale (Subramanyam *et al.*, 1982) on five random plants of each variety in each replication at the maturity stage. The average of three replications was considered as the disease percentage of the variety. Normal recommended package of practices were followed. No plant protection measures were given. The reaction of varieties to the disease

were classified based on per cent disease index. The variety ICGV - 92234 showed relatively low late leaf spot incidence (3%). The susceptible control variety TMV -2 recorded a disease percentage of 45%.

The resistant variety ICGV - 92234 gave a pod yield of 1280 kg/ha, shelling turn over of 68% and hundred kernel weight of 33g. The susceptible variety TMV -2 gave a pod yield of 808 kg/ha, shelling turn over of 70% and hundred kernel weight of 26.8 g. Varieties like ICGV - 92117, ICGV - 92195, ICGV - 92209, ICGV - 92217, ICGV - 92242 and ICGV - 92267 ICGV - 93382 and ICGV - 93437, though having low mean incidence of late leaf spot disease, recorded lowest pod yield.

Table : Evaluation of groundnut varieties against late leaf spot

S.No.	Cultivars	Mean of late leaf spot(%)	Pod yield (kg/ha)	Shelling percentage	100 kernel weight (g)
1.	ICGV - 92234	3.0	1280	68	33.0
2.	ICGV - 92217	15.0	1080	71	38.0
3.	ICGV - 92242	28.5	750	69	26.1
4.	ICGV - 92209	12.5	668	68	29.0
5.	ICGV - 92195	13.5	638	68	24.2
6.	ICGV - 93382	12.5	613	70	30.0
7.	ICGV - 92117	19.5	558	66	28.9
8.	ICGV - 93437	17.5	555	70	27.0
9.	ICGV - 92267	21.5	542	65	21.0
10.	JL - 24	23.0	1167	70	45.0
11.	Vemana	30.0	943	70	34.6
12.	Tirupati - 1	29.5	883	69	28.8
13.	TMV - 2	45.0	808	70	26.8

So, growing the resistant variety like ICGV - 92234 is the cheapest way of combating the late leaf spot disease. This resistant cultivar may be used in resistance breeding programme and also be recommended for cultivation in late leaf spot endemic areas.

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Effect of Date of Sowing and Plant Spacing on Mungbean Diseases with Reference to Mungbean Yellow Mosaic Virus

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ABSTRACT

In field trial to note the effect of planting time and spacings on mungbean yellow mosaic, root rot and leaf crinkle, early sown (12.07.99) mungbean attracted more (18.02%) mungbean yellow mosaic virus as compared to late sown (12.80%) in cultivar K-851. Similarly the disease incidence was 18.02%, 11.86%, 9.48% and 9.33% at row to row plant spacing of 25, 30, 37.5 and 45cm, respectively. The incidence of leaf crinkle and root rot increased with advancing date of sowing. However, yield decreases with advancing date of sowing.

.Key words : Date of Sowing, Plant Spacing, Mungbean, Mosaic

In India, Green gram is mainly grown during the rainy season (*kharif*) when the uneven conditions make them more vulnerable to the attack of diseases like; yellow mosaic, anthracnose, cercospora leaf spot and bacterial blight etc. causing heavy losses in yield.

Chandra (1984) reported that yellow mosaic alone can cause 30-70 per cent losses in yield. Grewal (1988) reported that yellow mosaic is serious in Madhya Pradesh, Bihar, Punjab, Haryana, Tamilnadu and Uttar Pradesh states of India causing 10-100 per cent losses in yield. In observations of Chand and Verma (1983) yield was reduced by 66.6 per cent due to attack by mungbean yellow mosaic virus.

Hence, the following experiments was laid out to note the effect of planting time and spacings on mungbean yellow mosaic virus, root rot and leaf crinkle.

MATERIAL AND METHODS

Effect of Sowing Time and Plant Spacing on Mungbean Diseases

To note the effect of date of sowing and plant spacing on mungbean yellow mosaic virus, root rot and leaf crinkle a field trial with susceptible mungbean cultivar K-851 was conducted. Dates of sowing were 12.07.99 (early), 25.07.99 (mid) and 06.08.99 (late). Four row to row plant spacings (25 cm, 30 cm, 37.5 cm and 45 cm) were maintained. The plot size was 5 x 3 m and there were three replications per treatment. The design used was split plot. Fertilizer application was done as per local need (Nitrogen 15 kg/ha and Phosphorus 40 kg/ha).

Observations for disease were made at 15 days interval after sowing. For recording disease score ten randomly selected plants per replication were observed. Observations for mungbean yellow mosaic virus were made

Table 1 : Effect of date of sowing and plant spacing on Mungbean Yellow Mosaic virus Infecting mungbean variety K-851

Row to Row spacing (cm)	Early (12-07-99)					Mid (25-07-99)					Late (06-08-99)				
	Disease score (1-9 scale)	% diseased plants	W.P.(H)	W.P.(D)	Y(q/ha)	Disease Score (1-9 scale)	% diseased plants	W.P.(H)	W.P.(D)	Y(q/ha)	Disease Score (1-9 scale)	% diseased plants	W.P.(H)	W.P.(D)	Y(q/ha)
25.0	6	18.02	5	6	11.3	5	13.73	08	13	9.9	6	12.80	11	11	8.07
30.0	5	11.86	4	5	12.0	5	10.07	08	09	9.2	5	07.36	13	15	8.06
37.5	5	09.48	5	5	12.7	5	07.03	06	09	8.3	5	06.34	11	15	6.32
45.0	5	09.33	4	3	14.7	5	06.62	13	13	7.9	5	03.62	13	13	5.42

C.D. (p = 0.05)

Yield

W.P.(D)

W.P.(H)

%Diseased
Plants

Dis.Score

Date of sowing :

NS

Plant spacings :

NS

Date of sowing :

NS

Plant Spacing

NS

Yield

0.35

0.42

0.21

W.P. (H) = Number of Whitefly/healthy plant

W.P. (D) = Number of Whitefly/diseased plant

Y(q/ha) = yield (quintal/hectare)

Table 2 : Effect of Date of Sowing and Plant Spacing on Root Rot of Mungbean Infecting variety K-851

Row to Row spacing (cm)	Per cent diseased plants		
	Early (12.07.99)	Mid (25.07.99)	Late (06.08.99)
25.0	2.84	3.04	4.57
30.0	2.34	2.67	4.07
37.5	2.09	2.29	3.36
45.0	1.79	2.04	2.97
C.D. (p = 0.05)	%Diseased Plants		
Date of sowing :	0.06		
Plant spacings :	0.04		
Date of sowings X :	0.07		
Plant Spacing			

following 1-9 scale suggested by Singh *et al.* (1992). In the case of root rot and leaf crinkle total number and diseased plants per replication were counted to calculate per cent disease incidence. Whitefly population was recorded using the split cage method given by Chhabra *et al.* (1979).

EXPERIMENTAL RESULTS

Effect of date of sowing and plant spacing on mungbean yellow mosaic virus infecting mungbean cultivar K-851

The disease incidence (Table 1) decreased significantly as the sowing time was advanced. This was true at all the four plant spacings. At 25 cm row to row plant spacing, the disease incidence was 18.02%, 13.73% and 12.80% in crop planted on 12.07.99, 25.07.99 and 06.08.99 respectively. Similar trend was recorded at other plant spacings. The disease incidence was significantly more at closer plant spacing at all the three sowing dates. In crop planted on 12.07.99 the disease incidence was 18.02%, 11.86%, 09.48% and 09.33% in crop planted at 25 cm, 30 cm, 37.5 cm and 45 cm row to row

spacing respectively. Similar trend was recorded in plantings done on other two dates. Although disease incidence decreased as the planting time was advanced yet yield also decreased with delaying sowing. At 25 cm spacing the yield in quintals/ha was 11.3, 9.9, 8.1 in sowing done on 12.07.99, 25.07.99 and 06.08.99 respectively. Similar were the observations with regard to other plant spacings. Disease data recorded using 1-9 scale did not differ significantly at different sowing dates and plant spacings. Highest whitefly population (11-13 whiteflies/plant) on healthy plants was recorded in late sown crop (06.08.99) and lowest (4-5 whiteflies/plant) in early sown crop (12.07.99). Almost similar were the observations with regard to whitefly population on diseased plants. Plant spacings had no effect on whitefly population.

Effect of date of sowing and plant spacing on root rot infecting mungbean cultivar K-851

Highest disease incidence (4.57%) was recorded in the late sown crop and minimum (2.84%) in the early sown crop (Table 2). This

Table 3 : Effect of Date of Sowing and Plant Spacing on Leaf Crinkle of Mungbean Infecting variety K-851

Row to Row spacing (cm)	Per cent diseased plants		
	Early (12.07.99)	Mid (25.07.99)	Late (06.08.99)
25.0	13.48	15.55	16.43
30.0	08.77	12.28	13.24
37.5	06.29	09.87	11.72
45.0	05.43	07.91	10.33
C.D. (p = 0.05)			
%Diseased Plants			
Date of sowing :	0.20		
Plant spacings :	0.17		
Date of sowings X :	0.30		
Plant Spacing			

was true at all the four plant spacings. At 25 cm row to row plant spacing, the disease incidence was 2.84%, 3.04% and 4.57% in crop planted on 12.07.99, 25.07.99 and 06.08.99 respectively. Similarity in the observations were recorded at other plant spacings. The disease incidence was significantly less at wider plant spacing at all the three sowing dates. In crop planted at 25 cm, 30 cm, 37.5 cm and 45 cm row to row spacing respectively. Observations recorded at other sowing dates had similar trend.

Effect of date of sowing and plant spacing on leaf crinkle infecting mungbean cultivar K-851

The disease incidence increased significantly as the sowing time was advanced at all the four plant spacings. At 25 cm row to row plant spacing, the disease incidence was 13.48%, 15.55% and 16.43% in crop planted on 12.07.99, 25.07.99 and 06.08.99 respectively. Similarly in the results was recorded at other plant spacings. The disease incidence was significantly in the results was recorded at other

plant spacings. The disease incidence was significantly more at closer plant spacing at all the three sowing dates. In crop planted on 12.07.99 the disease incidence was 13.48%, 8.77%, 6.29% and 5.43% in crop planted at 25 cm, 30 cm, 37.5 cm and 45 cm row to row spacing respectively. It was found true at other two sowing dates also (Table 3).

RESULTS AND DISCUSSION

In the present studies the incidence of anthracnose, leaf crinkle and root rot in mungbean decreased significantly as the sowing time was advanced of from 12.07.99 to 06.08.99 whereas, reverse was true in the case of mungbean yellow mosaic virus. The incidence of mungbean yellow mosaic virus, anthracnose, Orakhe and root rot was 18.02%, 2.77%, 13.48%, 2.84% respectively in early date of sowing (12.07.99) compared to 12.80%, 8.68%, 16.43% and 4.57% in late date of sowing (06.08.99) in cultivar K-851 at row spacing of 25 cm. the incidence of all the four diseases was higher at closer plant spacing (25 cm) as compared to wide

plant spacing (45 cm). yield was reduced significantly with delaying sowing.

The results of present investigation confirm the findings of Murugesan and Chelliah (1977) who reported that July to December sowings had less population of white flies than sowings from March to May which correlated with mungbean yellow mosaic virus incidence. High disease incidence and white fly population in March to May sowings were attributed to high temperature which prevailed during this period. In Haryana temperature levels are higher from March to April as compared to June to July. In studies of Nair and Nene (1973) incubation period of mungbean yellow mosaic virus infected seedlings was extended and transmission per cent was reduced from November to December when temperature was lower as compared to July and October. Nath and Saikia (1995) reported that warm weather and moderate level of humidity are favourable for spread of mungbean yellow mosaic virus at Assam, India.

In tests of Singh and Gurha (1994) mungbean genotypes showed higher mungbean yellow mosaic virus incidence and white fly population in summer when compared with spring or kharif season sowing. This was attributed to the unfavourable conditions for multiplication of the vector, *Bemisia tabaci* in the spring. However, in experiments of Keshwal and Saxena (1984) sowings from March to August did not affect mungbean yellow mosaic virus infection in Madhya Pradesh. Adebitan and Ikotun (1996) found that in the case of cowpea anthracnose increasing the spacing between and within rows decreased incidence and severity of the disease in mono and intercropped stands. In their studies

early sowings (23 July) were more vulnerable than later sowings (3 and 13 July) which is contrary to present observations. Present studies with regard to root rot confirmed the observations of Saxena (1979) who reported that disease was severe in dense crop canopy because it facilitates the pathogen for easy spread of disease.

Decrease in yield with delaying sowing mungbean has been reported in several earlier studies on yellow mosaic (Chand and Verma, 1983; Sushil Sharma *et al.*, 1993 and Grewal, 1988), root rot (Kaiser, 1970) and leaf crinkle virus (Kadian, 1982 and Bashir *et al.*, 1991).

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Studies on The Incidence of *Aspergillus niger* V. Teighem in Different Varieties of Groundnut

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ABSTRACT

Seeds of eleven groundnut varieties were screened for the incidence of *Aspergillus niger* V. Teighem. Among the varieties tested K-150, TPT-4, JL-24 and TMV-2 showed maximum incidence of *Aspergillus niger* in standard blotter method and the varieties JL-24, TAG-4, TMV-2 and K-150 recorded maximum incidence of *Aspergillus niger* when agar plate method was employed. All the varieties tested showed the incidence of *Aspergillus niger*.

Key words : *Aspergillus*, groundnut

Crown rot or collar rot of groundnut caused by *Aspergillus niger* v. Teighem is distributed throughout the world (Feakin, 1973). Pre emergence rotting of the seeds due to the fungus is common. Seed borne nature of the fungus has been well documented (Jackson, 1964; Ashworth, 1963). Therefore selected groundnut cultivars were screened *in vitro* for incidence of *Aspergillus niger*.

MATERIAL AND METHODS

Eleven groundnut cultivars (DRG-12, Gulabi, JL-24, JL-24(N), K-150, K-134, Somnath, TAG-4, TCGS-320, TMV-2 and TPT-4) were tested for the incidence of *Aspergillus niger* adopting Standard Blotter and Agar Plate methods. In each of the methods used three replications were maintained with 10 seeds per plate of each variety in each replication. The plates were incubated at $25 \pm 2^\circ\text{C}$ with alternating cycles of 12 h light and 12 h darkness for seven days. White light was provided by placing two 40 watt day light fluorescent tubes in a horizontal position 20 cm apart at a height of approximately

41 cm above the seed. The seeds were examined daily for the incidence of *A. niger* for 7 days. The incidence of *A. niger* was recorded by counting the number of seeds colonized by *A. niger* in each of the replications and the per cent incidence of the isolate was calculated following the formula given below as suggested by Jha (1995).

No. of seeds colonized in each plate by *Aspergillus niger*

% incidence = ... x 100

Total number of seeds in each plate

RESULTS AND DISCUSSION

The seeds of all the varieties tested by standard blotter and agar plate method revealed the association of *A. niger* with the seed. However, significant differences were observed among the varieties in the incidence of *A. niger* in both the methods tested. K-150 recorded the highest incidence (46.67%) followed by TPT-4 (46.66%), TAG-4 (43.33%), JL-24 (26.66%) and TMV-2 (33.33%) when

Table : Effect of Storage period on the incidence of *Aspergillus niger*

Storage Period (Days)	Per cent incidence of <i>Aspergillus niger</i> *
30	62.50 (52.27)
60	63.75 (52.99)
90	67.50 (55.36)
120	67.50 (55.38)
150	72.50 (58.45)
SEM _±	1.97
CD (0.05)	5.95

* Mean of four replications.

Figures in parenthesis are arc sine transformed values.

standard blotter method was employed. The variety JL-24 (N) recorded maximum incidence 90.00 per cent followed by TAG-4 (83.33%), somnath (80.00%), TMV-2 (73.33%) and K-150 (70.00%) when agar plate method was used. Between the agar plate and standard blotter paper methods the agar plate method was found to be superior in revealing the presence of *A. niger* in the seed in the present study. Differential resistance found in the groundnut varieties in the

present study may be due to the differences in the structural and biochemical features of different varieties (Pettit *et al.*, 1989). Mixon (1980) observed less seed colonization by *A. niger* in varieties resistant to collar rot disease than the susceptible varieties. The findings of the present study are confirmed by above reports.

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Effect of Culture Filtrate of *Colletotrichum gloeosporioides* Penz. on Cashew Seedlings

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ABSTRACT

The adverse effect of crude culture filtrate of *Colletotrichum gloeosporioides* and the dilutions of the culture filtrate viz., 1:10, 1:100 and 1:1000 was studied on the cashew seedlings. Crude culture filtrate produced the adverse effects like yellowing, drying and scorching of leaves finally leading to the death of the cashew seedlings, whereas the diluted culture filtrate did not produce any adverse effects on cashew seedlings.

Key words : *Colletotrichum gloeosporioides*, Cashew

India is the largest producer, processor and exporter of cashew kernels. It is one of the most important foreign exchange earning crops of the country. Andhra Pradesh is one of the major cashew growing states in India where it is mostly grown in sandy soils of coastal districts. Anthracnose, common on cashew and mango gardens, has also started appearing on cashew seedlings in the nurseries in destructive form in recent times, and is one of the major constraints in the production of successful grafts. In order to understand the effect of culture filtrate of *C.gloeosporioides* on cashew seedlings, the present investigation was taken up.

MATERIAL AND METHODS

The culture filtrate was prepared by growing the fungus on potato dextrose broth for 10 days and filtering the contents through Whatman No. 41 filter paper. The filtrate was collected and used. Different dilutions of the culture filtrate were prepared viz., crude extract, 1:10, 1:100, 1:1000. The seedlings of cashew

were individually sprayed with culture filtrates of each dilution with the help of a hand sprayer and covered with polythene bags to maintain humidity. For each dilution of culture filtrate, 10 seedlings were used with each seedling as one replication. The number of leaves showing scorching or browning or wilting symptoms were counted and expressed as per cent leaves showing scorching.

RESULTS AND DISCUSSION

Only crude culture filtrate was effective in producing the adverse effect on cashew seedlings. The culture filtrate at 1:10, 1:100, 1:1000 dilutions did not produce any drying or scorching or any form of adverse effect on the leaves. Initially, three days after spraying of seedlings with crude culture filtrate, only 32.59 per cent leaves exhibited the adverse effect in the form of drying, scorching or wilting. However, five days after spraying, the number of leaves affected increased (55.11 per cent). There was a marked increase in the percentage of leaves

Table : Effect of culture filtrate of *Colletotrichum gloeosporioides* and its dilution on Cashew Seedlings

Treatment	Per cent leaf drying and* Extent of drying of leaves			
	Days after spraying			Mean
	3	5	7	
Crude extract	32.59	55.11	63.18	50.29
1:10 dilution	++	+++	+++++	
1:100 dilution	0.00	0.00	0.00	0.00
1:1000 dilution	0.00	0.00	0.00	0.00
Sterile water	0.00	0.00	0.00	0.00

* Mean of ten replications

+ Yellowing of leaf tip

++ Drying of leaf tip and leaf margin; the entire leaf turns yellow; few leaves turn brown.

+++ Drying of almost all leaves; the plant showed withering

+++++ Dropping of dried leaves; plants showed dying

- No visual symptoms can be seen; the plant looks healthy and normal.

showing adverse effect (63.18 per cent) seven days after spraying of the seedlings with crude culture filtrate (Table). The adverse effect was acute leading to the drying and defoliation of leaves and death of seedlings. In the seedlings sprayed with crude culture filtrate of the fungus, yellowing and drying of leaf tip and leaf margin were seen accompanied with yellowing of the entire leaf three days after spraying. A gradual increase in the per cent leaf area showing drying

was observed and seedlings also started showing the sign of withering five days after spraying. At this stage most of the leaves of the cashew seedlings dried. After seven days of spray, the leaves that had dried fall off and the seedling started dying. In the case of diluted culture filtrate, the seedlings sprayed with 1:10 dilution showed yellowing of leaf tip three days after spraying, but it soon disappeared and the seedlings looked normal again after seven days.

No visual symptoms were observed with any other dilution of the culture filtrate. The adverse effects of culture filtrates of *C. gloeosporioides* were described on sweet lime (*Citrus limettoides*), betel vine (*Piper betle* L.) and coriander (*Coriandrum sativum*) (Sharma and Sharma, 1969; Naik *et al.*, 1989; Naik *et al.*, 1991). The adverse effects described in the above reports like wilting, drying, falling of leaves, inward curling, marginal necrosis, drooping of leaves, are similar to the effects observed in the present study. It was suggested that toxic metabolites produced by *C. gloeosporioides* were involved in the production of anthracnose disease on betel vine, coriander, sweet lime. The toxic metabolites involved were found to be thermolabile and non-specific (Naik *et al.*, 1989; Naik *et al.*, 1991; Sharma and Sharma, 1969). The results of the present study suggest the possible role of toxic metabolite in the pathogenesis of *C. gloeosporioides*.

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Variation of Total Phenolics at Different Stages of Tree Growth in Mango (*Mangifera indica* L.) and Their Characterization

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ABSTRACT

Total phenolic content in bark was determined in five growth stages of mango (*Mangifera indica* L.) and significant differences were observed between different varieties. Irrespective of the stage of sampling, dwarf cultivars had the highest amount of phenolics. To obtain comparative data, it is very necessary that samples for phenolic analysis have to be taken at the same stage in all the cultivars. There was no distinct relationship between tree vigour and total flavonoids and mangiferin concentration in bark. Therefore, flavonoid content and mangiferin concentration in bark might not be a good indicator to predict tree size.

Key words : Phenolics, Mango

The mango (*Mangifera indica* L.) is one of the most important fruit crops of the tropical regions of the world. It enjoys the same popularity as apple does in the temperate regions.

The importance of dwarf trees has been realized with the concept of high density planting system for various fruit trees. The higher productivity in dwarf trees probably is due to a reduction in the distance between the translocation of assimilates to the fruits besides higher number of trees per unit area (Tyagi, 1986) and reduction of mango tree size would provide an opportunity to increase land utilization efficiency and decrease production costs (Weng-yitzu *et al.*, 2000)

A simple test to identify dwarf clones in mango is of practical use in breeding or selection programmes designed to obtain dwarf genotypes. However, no information is available about the nature of phenolics occurring in mango and hence

the present study was undertaken to identify phenols and study the variation in phenolic content during different phenological stages in mango.

MATERIAL AND METHODS

The experiment was conducted at the experimental field and laboratories of the Indian Institute of Horticultural Research, Hessarghatta, Bangalore, during 1991 and 1992. Seven varieties of mango were selected for the study. Out of which, three dwarf (Kerala dwarf, Kodur hybrid and Amrapali), two were medium vigorous (Alphonso and Janardhana Pasand) and two were tall (Gola and Chandrakaran). In each variety, a set of three trees were selected and this set of three trees were considered as replication and thus there were seven varieties replicated thrice and the design of experiment was randomized block design. The trees were 15 years old and given uniform cultural treatments.

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Table 1 : Variation in bark phenolic content expressed in mg per cent (on fresh weight basis) for different mango varieties during different stages of tree development

Variety	Before flowering	During flowering	During fruit growth	After harvest	Active shoot growth
Kerala dwarf	3608.5	3139.5	4222.4	3900.0	3294.3
Kodur hybrid	2825.0	3472.9	3983.2	4262.4	3451.0
Amrapali	2787.3	3293.2	4368.2	4443.5	3677.4
Janardhana	2761.0	2971.9	3246.9	3846.1	2750.0
Pasand					
Alphonso	3096.2	3067.2	3902.3	4865.8	3715.4
Gola	1548.1	2810.3	3179.0	3478.0	3031.0
Chandrakaran	708.3	1491.6	1495.4	2007.3	1445.3
F test	*	*	*	*	*
CD at 5%	627.4	453.0	784.5	419.5	309.7
SEm±	203.6	147.0	254.6	136.1	100.5
CV%	14.3	8.8	12.6	6.2	5.7

Phenolic content in the bark was determined in seven varieties of mango during the following different stages of tree growth by using calorimetric procedure described by Giebel (1970).

- (i) Before flowering (Dec, 1991)
- (ii) During flowering (Jan - Feb, 1992)
- (iii) During fruit growth (April, 1992)
- (iv) After harvest (June, 1992) and
- (v) Active shoot growth (Sept, 1992)

The pooled phenolic extract from three replications was used for flavonoid estimation. Mangiferin was estimated for the sampling stage active shoot growth by using paper chromatography and therefore data on flavonoid and mangiferin concentration was not subjected to statistical analysis.

RESULTS AND DISCUSSION

In general, it was observed that when sampled at a particular stage in all the cultivars, the dwarf varieties had the maximum amount of phenolics as compared to vigorous cultivars (Table 1). Since wide variation was observed with regard to the total phenols at various stages, the present studies indicate that in any comparative study or in studies involving prediction of vigour based on phenolic content, it is necessary to sample all the plants at the same phenological stage to arrive at a meaningful conclusions. These results may be attributed to the inhibitory effects of phenols on growth by inhibiting cell division and cell elongation through its effect on the level of auxin in plant tissue (Kefeli and Kutacek, 1976). These results were in conformity with findings of earlier scientists Babu *et al.* (1985), Kurian, (1989) and Kurian *et al.* (1994).

Table 2 : Total flavonoid content in the bark expressed in mg per cent (on fresh weight basis) for seven varieties of mango during different stages of tree development

Variety	Before flowering	During flowering	During fruit growth	After harvest	Active shoot growth
Kerala dwarf	640.0	590.0	590.0	740.0	780.0
Kodur hybrid	600.0	740.0	720.0	730.0	740.0
Amrapali	660.0	750.0	790.0	790.0	810.0
Janardhana	600.0	630.0	690.0	720.0	750.0
Pasand					
Alphonso	580.0	670.0	730.0	740.0	760.0
Gola	590.0	640.0	690.0	740.0	790.0
Chandrakaran	440.0	650.0	680.0	700.0	710.0

Table 3 : Mangiferin concentration expressed in mg per cent on fresh weight basis in seven varieties of mango for the stage active shoot growth

Variety	Mangiferin concentration (mg %)
Kerala dwarf	718.0
Kodur hybrid	809.0
Amrapali	965.0
Janardhana Pasand	750.0
Alphonso	569.0
Gola	505.0
Chandrakaran	609.0

The varieties, Janardhana Pasand, Gola, Alphonso and Chandrakaran showed consistent increase in flavonoid content from before flowering to active shoot growth (Table 2).

The total flavonoid content during different stages did not have any distinct relationship with tree vigour. Similar results were obtained by Feucht and Forche (1975) in prunus species that monomeric and oligomeric flavans in shoot tips had no relationship with tree vigour in apple.

The total flavonoid content constituted 24.76 per cent of the total phenolics. Hence, flavonoids are not the major components of phenols in the bark. The major flavonoid in the bark of seven mango varieties was identified as mangiferin. Hence, mangiferin was determined for the sampling stage active shoot growth (Table 3). Similar observations was made in mango by Saleh and Ansari (1976). They identified mangiferin as the major component of leaves and twigs.

Present studies have indicated the role of phenolics in tree size, it is not clear whether this is the cause or the result of this character.

The total flavonoid content in bark during different stages of tree growth did not show distinct relationship with tree vigour. Mangiferin concentration in bark might not be a good indicator to predict the tree size in mango. However, further study is needed in identification of other constituents of phenolics responsible for tree vigour in mango.

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Effect of Bioregulators on Growth and Yield of Betelvine (*Piper betle* L.)

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ABSTRACT

In a field trial to study the effect of bioregulators on growth and yield of betelvine, the vine elongation and number of laterals per vine were significantly influenced by triacontanol 0.05% triple spray at monthly intervals starting from 2 months after planting. Shorter internodal length which is preferred by a commercial grower was recorded by triacontanol 0.05% triple spray. Number of leaves per vine and leaf yield per hectare were significantly influenced by triacontanol 0.05% triple spray with an yield of 87.81 lakh leaves per hectare.

Key words : Bioregulators, Betelvine

Betelvine (*Piper betle* L.) is grown throughout India on commercial scale for its leaf. It had got many medical values as digestive, aromatic, deodorant mouthwash, antiseptic, poultice for boils, stimulant, carminative and also used in curing catarrhal pulmonary diseases (Burkill, 1935). However, very little research efforts have been carried out so far towards the development of new production technology. Apart from normal manuring and fertilizer application growth and productivity of betelvine can also be improved with the help of bioregulators. The earlier reports showed good response of several crops due to the application of bioregulators (Bharud *et al.*, 1988 and Singh *et al.*, 1990). Therefore, it is felt necessary to study the effect of bioregulators on vine growth and leaf yield of betelvine under local agro. climatic conditions.

MATERIAL AND METHODS

The field experiment was conducted at Betelvine Research Station, Chintalapudi during 2001-2002 on clay loam soils. The variety selected for study was Ponnur Tellaku (Kapoori type). The experiment was laid out in RBD design with three replications. There were 15 treatments

involving five growth regulators (NAA 50 ppm, GA 50 ppm, BA 50 ppm. Triacontanol 0.05% and water) and spraying as single spray, double spray and triple spray at an interval of 30 days starting from second month after planting. Uniform cultural practices were adopted in all treatments throughout the experimental period. Data were collected on vine elongation, number of laterals per vine, internodal length, leaf area, number of leaves per vine and leaf yield per hectare and were subjected to statistical analysis as suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Vine elongation

The vine elongation representing the growth as influenced by bioregulators (Table 1) showed non significant differences at 3 and 4 month stages, but significant differences were observed from 5 month stage onwards. It indicates that the bioregulators were not effective in early stages of vine elongation. However, among bioregulators triacontanol 0.05% triple spray which were on par with each other. Further these bioregulators were showing similar effect

Table 2 : Effect of bioregulators on internodal length and leaf area starting at 3 months of planting to 7 months age of crop (i.e. lowering of the first year crop)

Treatments	Internodal Length (cm)					leaf area (cm ²)				
	3M	4M	5M	6M	7M	3M	4M	5M	6M	7M
1. NAA 50 ppm	8.72	8.89	8.87	8.60	8.75	60.69	56.42	55.34	73.02	86.54
2. NAA 50 ppm	8.96	8.73	9.01	8.82	8.83	58.42	50.23	51.11	65.81	86.16
3. NAA 50 ppm	8.85	8.65	8.63	8.62	8.62	61.36	52.81	45.78	60.96	80.09
4. GA 50 ppm	10.43	10.51	10.32	10.12	9.86	103.83	107.62	108.55	105.52	100.42
5. GA 50 ppm	10.32	12.76	12.63	10.98	10.23	100.21	112.10	114.12	107.96	101.93
6. GA 50 ppm	10.46	12.53	15.01	12.96	10.95	102.66	115.35	123.25	110.86	103.81
7. Triacntanol 0.05%	6.87	6.86	6.94	6.98	7.03	87.71	89.01	90.32	88.43	87.92
8. Triacntanol 0.05%	6.93	6.36	6.36	6.76	6.84	88.48	92.02	92.72	88.83	89.03
9. Triacntanol 0.05%	6.98	6.41	5.82	6.23	6.78	90.32	91.58	95.69	92.78	89.68
10. BA 50 ppm	8.63	8.71	8.82	8.72	8.79	87.46	88.65	86.86	89.33	86.42
11. BA 50 ppm	8.59	8.86	8.59	8.80	8.53	86.92	87.79	86.70	85.56	88.39
12. BA 50 ppm	8.71	8.58	8.74	8.66	8.86	88.63	87.46	87.68	87.49	87.92
13. Water	8.84	8.83	8.63	8.87	8.72	85.32	88.81	85.76	86.18	84.65
14. Water	8.58	8.62	8.72	8.92	8.93	89.10	86.53	87.13	84.72	85.96
15. Water	8.78	8.73	8.96	8.69	8.82	87.92	89.06	86.98	84.68	86.16
SEm ±	0.26	0.27	0.61	0.43	0.32	5.17	4.41	7.68	4.72	4.82
CD (p=0.05)	0.77	0.79	1.77	1.25	0.94	14.98	12.79	22.24	13.67	NS
CV%	5.34	5.29	11.69	8.48	6.49	10.51	8.85	15.37	9.34	9.32
Mean value of										
NAA	8.84	8.75	8.83	8.68	8.73	60.15	53.15	50.74	66.59	84.26
GA	10.40	11.93	12.65	11.35	10.34	102.23	111.69	115.30	108.11	102.05
Triacntanol	6.92	6.54	6.37	6.65	6.88	88.83	90.87	92.90	90.01	88.87
BA	8.64	8.71	8.71	8.72	8.72	87.67	87.96	87.08	87.46	87.57
Water	8.73	8.72	8.77	8.82	8.82	87.44	88.13	86.62	85.19	85.59

at any number of sprayings. It explains that the influence of GA 50 ppm and triacontanol irrespective of number of sprays have shown a similar influence on betelvine growth. In otherwards it demonstrated that similar influence of costly GA could be achieved with the spraying of cheaper triacontanol 0.05%. The increase in growth of betelvine due to triacontanol application could be attributable to enhancement in water uptake, cell enlargement and metabolic efficiency as suggested by Ries (1978). GA increased the vine length due to its typical action of cell elongation and cell wall plasticity (Randhawa 1971). BA 50 ppm showed lower growth rate compared to control. Among number of sprayings, improvement of growth was observed with increase in number of sprayings of GA 50 ppm and triacontanol 0.05%, which could be due to the cumulative action of these substances after each spray in their respective treatments. However, there were no significant differences between the number of spraying of GA 50 ppm.

Number of laterals per vine

Table 1 showed significant differences among the treatments at all stages of vine growth. Among bioregulators triacontanol showed a significant influence on the production of laterals. The increased production of laterals with increase in number of sprayings of triacontanol from 5 month stage could may be due to the cumulative action of triacontanol. Similar results of triacontanol 0.05% triple spray was reported by Arulmozhiyan (1997). It could be due to breaking of apical dominance and thereby production of laterals (Ries *et al.*, 1978). The superior influence of BA 50 ppm and inferior influence of GA in the production of laterals per vine in the study could be their action of promoting cell division process and promotion of apical dominance respectively.

Internodal length

The internodal length was significantly influenced by GA 50 ppm irrespective of number of sprays NAA 50 ppm, BA 50 ppm and water were on par with each other at any number of sprayings (Table 2). Thus GA 50 ppm proved to be the promoter of vine length by cell elongation and thus resulted in increased internodal length. Similar results were reported by Rahemi and Baninasab (2000) and Tajuddin *et al.*, (1997). Contrarily, triacontanol 0.05% significantly reduced internodal length and increased lateral production. In a crop like betelvine it is the number of laterals per vine that matters the leaf yield. Among number of sprays triacontanol 0.05% triple spray was found to be the better in reducing the internodal length, increasing number of nodes and leaf number per vine and found to be an important input to improve the productivity.

Leaf Area

Leaf area as influenced by bioregulator and their sprayings (Table 2) showed significant differences upto 6 months stage of the crop. Large betel leaf area was recorded by GA 50 ppm irrespective of number of sprays. This could possibly be due to increased water uptake as suggested by Rahemi and Baninasab (2000). The leaf area recorded due to sprayings of triacontanol 0.05%, BA 50 ppm and water spray are more or less similar without much variation in leaf area, indicating that normal leaf area was developing even after spraying of these substances. In betelvine markets leaf of unusal size is not preferred. However, leaf area was the lowest incase of NAA 50 ppm treated plants which could possible be attributable to synthesis of ethylene that might have reduced the leaf area and induced epinastic curvature of leaf. Similar reduced leaf area and epinastic effect of NAA was reported by Taiz and Zeiger (1991).

Table 3 : Effect of bioregulators on number of leaves per vine and leaf yield per hectare starting at 3 months of planting to 7 months age of crop (i.e. lowering of the first year crop)

Treatments	Number of leaves/vine					Leaf yield per hectare (No. of leaves in lakhs/ha)
	3M	4M	5M	6M	7M	
1. NAA 50 ppm	36.22	50.21	62.69	73.42	85.13	42.565
2. NAA 50 ppm	34.00	46.82	58.26	69.19	80.71	40.355
3. NAA 50 ppm	34.62	47.03	53.27	63.39	75.32	37.660
4. GA 50 ppm	47.32	60.23	77.39	100.43	120.17	60.085
5. GA 50 ppm	46.00	66.02	83.29	104.13	122.72	61.360
6. GA 50 ppm	47.98	66.47	88.26	109.91	126.36	63.180
7. Triacotanl 0.05%	54.72	78.62	107.62	143.39	164.69	82.345
8. Triacotanl 0.05%	55.69	81.00	112.33	147.33	167.40	83.700
9. Triacotanl 0.05%	54.40	80.19	120.66	156.77	175.62	87.810
10. BA 50 ppm	48.69	68.63	87.03	107.37	123.18	61.590
11. BA 50 ppm	49.38	78.29	100.33	115.39	129.98	64.990
12. BA 50 ppm	49.18	78.62	109.60	126.93	137.32	68.660
13. Water	41.47	56.30	68.32	82.27	94.34	47.170
14. Water	41.33	57.00	67.84	82.85	93.12	46.560
15. Water	40.89	55.62	68.00	81.09	95.17	47.585
SEm $\pm$	1.91	2.88	2.96	4.74	5.21	3.30
CD (p=0.05)	5.55	8.34	8.58	13.75	15.11	6.77
CV%	7.31	7.71	6.09	7.88	7.56	6.78
Mean value of						
NAA	34.94	48.02	58.07	68.66	80.38	40.19
GA	47.10	64.24	82.98	104.82	123.08	61.54
Triacotanl	54.93	79.93	113.53	149.16	169.23	84.61
BA	49.08	75.18	98.98	116.56	130.16	65.08
Water	41.23	56.30	68.05	82.07	94.21	47.10

Table 4 : Economics of bioregulators application

Treatments	Leaf yield (lakh leaves/ha)	Additional leaf yield over control (lakh leaves/ha)	Income over control (Rs./ha)	Gross expenditure over control (Rs./ha)	Net return. over control (Rs./ha)
NAA 50ppm SS	42.57	-4.6	-3450	490	-3940
NAA 50ppm DS	40.36	-6.2	-4650	684	-5334
NAA 50ppm TS	37.66	-9.93	-7447.5	878	-8325.5
GA 50ppm SS	60.09	12.93	25840	13397.5	12442.5
GA 50ppm DS	61.36	14.80	29600	16932	12668.0
GA 50ppm TS	63.18	15.59	31180	19024	12156.0
Triacantanol 0.05% SS	82.35	35.18	70360	27110	43250
Triacantanol 0.05% DS	83.70	37.14	74280	28135	46145
Triacantanol 0.05% TS	87.81	40.22	80440	30550	49890
BA 50ppm SS	61.59	14.42	28840	13065	15775
BA 50ppm DS	64.99	18.43	36860	17422.5	19437.5
BA 50ppm TS	68.66	21.07	42140	20752.5	21387.5
Water SS	47.17	—	—	375	—
Water DS	46.56	—	—	500	—
Water TS	47.59	—	—	625	—

Prices : NAA Rs.4.60/g, GA Rs.133.3/g, BA Rs.180/g

Triacantanol Rs. 70/100 ml

Single spray (3 labourers) Rs. 150/-; Double spray

(4 labourers) Rs.200/-, Triple spray (5 labourers) Rs.250/-,

Harvesting of 100 leaves Rs.0.75/-, cost of 100-leaves in
local market Rs.2/-

Gross expenditure : Harvesting charges + labourers charge for
sprayings + cost of NAA/GA/Triacantanol/BA.

Number of leaves per vine and yield per hectare

It depends upon vine elongation and number of laterals produced by each vine. Among bioregulators triacantanol 0.05% recorded maximum number of leaves with a progressive increase in leaf yield per vine with increase in number of sprayings of triacantanol (Table 3).

Pertaining to number of sprayings triple spray of triacantanol 0.05% was found to be more effective and efficient from 5 month stage compared to other bioregulators and their sprayings. Although GA 50 ppm either triple or double spray showed similar influence on vine growth, its influence on number of leaves per vine was low compared to triacantanol. Thus it

clearly explains that it was not vine length but it was the number of leaves produced per vine contributed to higher leaf yield. Maximum leaf yield of 82.25 to 87.81 lakh leaves per hectare were recorded by triacontanol 0.05% spraying (Table 3).

Economics

The economic analysis revealed that triacontanol among bioregulators recorded more net returns from one hectare compared to others (Table 4). The highest monetary returns of 49.890/- per hectare over control was recorded by triacontanol 0.05% triple spray followed by double spray which were associated with more additional yield of betel leaf and gross income over control. It is concluded that triacontanol 0.05% was found to be more efficient not only in increasing the growth and leaf yield per unit area but also in terms of net returns.

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Nutrient Uptake as Influenced by Nitrogen and Potassium Sources and Their Time of Application in Onion.

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ABSTRACT

A field trial with four sources of nitrogen and potassium and their combination viz., urea + sulphate of potash, ammonium sulphate + sulphate of potash, urea + muriate of potash, and ammonium sulphate + muriate of potash and three times of application (entire fertilizer as basal dose, half nitrogen and half potassium dose as basal + half nitrogen and half potassium dose as top dressing on thirty days after transplanting (DAT); half nitrogen and half potassium fertilizer basal + one fourth nitrogen and one fourth potassium dose as top dressing on sixty DAT) was conducted in sandy loam soils of Agricultural College Farm, Bapatla, during 2001-02. Among the sources, application of ammonium sulphate + sulphate of potash significantly influenced the nutrient uptake at 60 days after transplanting (DAT) and 90 DAT, recording a maximum of 27.02 N Kg ha⁻¹, 6.03 P Kg ha⁻¹ and 35.99 K Kg ha⁻¹ at 90 DAT. Among the split application, three split application recorded maximum nitrogen and phosphorus at 90 DAT namely 26.34 and 5.34 Kg ha⁻¹ but potassium uptake was markedly influenced by two split application recording 35.65 Kg ha⁻¹.

Key words : Nutrient Uptake, Nitrogen, Potassium, Onion

Onion in recent years has gained commercial importance in Andhra Pradesh. Since it is an exhaustive crop, it may impoverish the soil further. The magnitude of nutrient removal in intense crop production would be much higher. Therefore, an investigation to understand the N, P, K, uptake pattern in onion is necessitated.

MATERIAL AND METHODS

A field experiment was conducted to study the effect of nitrogen and potassium sources and their time of application on nutrient uptake in onion Cv. N-53 during the *rabi* season of 2000-02 at Agricultural College Farm, Bapatla. The experiment was laid out in Randomized Block Design with factorial concept in three replications. The treatment consisted of combination of nitrogen and potassium sources viz., S₁ - urea + sulphate of potash, S₂ - ammonium sulphate + sulphate of potash, S₃ - Urea + muriate of potash, S₄ - ammonium sulphate + muriate of potash

and time of fertilizer application (T₁ - entire N and K₂O dose as basal, T₂ - 1/2 N + 1/2 K₂O as basal, 1/2 N + 1/4 K₂O as top dressing on 30th DAT (Days after transplanting), T₃ - 1/2 N + 1/2 K₂O as basal + 1/4 N + 1/4 K₂O as top dressing on 60th DAT. Single super phosphate was applied as a common basal dose. Nutrient uptake studies were made from plant samples of 30, 60 and 90 DAT using the modified microkjeldahl method (AOAC, 1960) for N, Vanado Molybdophosphoric yellow colour development method (Jackson, 1973) for P and Flame Photometry method for K (Jackson, 1973).

RESULTS AND DISCUSSION

Nitrogen Uptake

Regarding the nitrogen uptake the data presented in Table 1 showed a gradual increase with age of the crop and found to be maximum on 90 DAT. Further, there was statistical difference among the source of N and K, and

Table1 :Nitrogen uptake (kg per hectare) as influenced by Nitrogen and potassium sources and their time of application 30th, 60th, 90th DAT

Sources	30 DAT					60 DAT					90 DAT				
	T ₁	T ₂	T ₃	Mean		T ₁	T ₂	T ₃	Mean		T ₁	T ₂	T ₃	Mean	
S ₁	0.94	0.95	0.70	0.79		1.58	2.08	1.86	1.84		22.74	25.20	25.93	24.63	
S ₂	1.03	0.83	0.77	0.88		3.30	3.85	3.48	3.54		26.63	28.15	26.15	27.02	
S ₃	0.65	0.72	1.08	0.82		2.60	2.60	2.50	2.56		23.63	23.20	27.39	24.74	
S ₄	0.99	1.09	1.00	1.03		2.30	3.10	2.30	2.56		23.44	27.93	25.81	25.72	
Mean	0.90	0.85	0.89	-		2.44	2.90	2.53	-		24.13	26.12	26.34	-	
	F-TEST	SED±	CD	CV%		F-TEST	SED±	CD	CV%		F-TEST	SED±	CD	CV%	
Sources (S)	S	0.07	0.15	18.28		S	0.22	0.46	17.97		S	0.84	1.74	6.90	
Time of Application (T)	NS	-	-	-		S	0.19	0.40	-		S	0.72	1.51	-	
Interaction (S x T)	S	0.32	0.27	-		NS	-	-	-		S	1.45	3.01	-	

their times of application at all stages except on 60 DAT, where non-significant differences were recorded for interactions of sources and times of application. Among the sources of N and K fertilizer application, S₂ i.e., ammonium sulphate + sulphate of potash showed maximum uptake of nitrogen at 60 DAT and 90 DAT. However, at 30 DAT S₄ (ammonium sulphate + Muriate of potash) showed maximum uptake. These results clearly indicated the superiority of ammonium sulphate to other sources which may be attributed to the high solubility and adequate supply of nutrients to the crop and thus an increase in growth. With respect to time of application, maximum uptake of nitrogen was recorded by T₂ at 60 DAT and T₃ followed by T₂ at 90 DAT. This result is clearly indicating that the maximum nitrogen uptake by the onion crop could be achieved with two-split application. Even if third split application is given, it may result in the uptake of same quantity of nitrogen from the soil. In other words, the extra split application may result in leaching of nitrogen into the soil or other form of loss and may not be utilized by the crop. Further, the extra cost of third split application could be avoided, if only two split application of sulphur containing fertilizers are applied. Pertaining to the interactions of source of N and K and their time of application, S₂ T₂ i.e., application of sulphur containing fertilizers in two split application 1/2 basal + 1/2 at 30 DAT, have registered the maximum uptake of nitrogen. This is confirming the results obtained from the independent components of sources and time of application.

Phosphorus uptake

The data for phosphorus uptake in the Table 2 indicated that the phosphorus uptake was found to be gradually increased with the age of the crop and found maximum at 90 DAT in all treatments. The significant difference of maximum uptake, however, was recorded by

Table 2 :Phosphorus uptake kg /hectare as influenced by Nitrogen and potassium sources and their time of application 30th, 60th, 90th DAT

Sources	30 DAT					60 DAT					90 DAT				
	T ₁	T ₂	T ₃	Mean		T ₁	T ₂	T ₃	Mean		T ₁	T ₂	T ₃	Mean	
S ₁	0.17	0.06	0.07	0.10		0.60	0.90	0.53	0.67		1.73	4.20	4.93	3.62	
S ₂	0.20	0.14	0.13	0.15		0.92	2.07	0.96	1.32		5.63	7.15	5.25	6.03	
S ₃	0.14	0.17	0.17	0.16		0.65	0.65	0.74	0.68		2.63	2.20	6.39	3.74	
S ₄	0.13	0.20	0.17	0.16		0.53	1.03	0.83	0.80		2.40	6.93	4.81	4.72	
Mean	0.16	0.14	0.37	-		0.67	1.17	0.76	-		3.13	5.12	5.34	-	
	F-TEST	SED±	CD	CV%		F-TEST	SED±	CD	CV%		F-TEST	SED±	CD		
Sources (S)	NS	-	-	24		S	0.20	0.43	25		S	0.84	1.76	29	
Time of Application (T)	NS	-	-	-		S	0.17	0.37	-		S	0.73	1.52	-	
Interaction (S x T)	NS	-	-	-		NS	-	-	-		NS	-	-	-	

sources of N and K fertilizer and time of application of 60 DAT and 90 DAT, indicating that the sources of fertilizers and time of application and their interaction are different and independent to each other. A maximum uptake of 6.03 kg/hectare of 'P' was recorded by S₂ treatment (i.e., ammonium sulphate + sulphate of potash) fertilizers at 60 DAT and 90 DAT. These results are in tune with findings of Singh *et al.*, (1995) in garlic. It could be attributed to the sulphur available in the N and K fertilizers applied that might have resulted in the availability of phosphorus for maximum uptake for onion crop in the present study. Pertaining to the time of application of fertilizers, two-split application on 60 DAT and three-split application on 90 DAT have recorded maximum uptake of phosphorus. It is interesting to note that contrary to nitrogen uptake, the third split application of fertilizers made available the phosphorus to the onion crop. This could be attributed to the synergistic effect of sulphur containing fertilizers on the availability of phosphorus to the crop, which is an extra application. Among the interactions, maximum 'P' uptake was recorded by S₂T₂ (application of ammonium sulphate + SOP in two split application) at 60 DAT and 90 DAT. The increase in the availability of nutrients with constant regular application of irrigation may be responsible for higher uptake of phosphorus as in the case of nitrogen.

Potassium uptake

Regarding Potassium uptake in the present study, the uptake of potassium increased with age of the crop and reached maximum at 90 DAT, in all treatments and their combinations. The treatment S₂ (ammonium sulphate + sulphate of potash) recorded maximum uptake of potash on 60 DAT, 90 DAT and found to be statistically superior over other sources. This could be attributable to the availability of potassium ions freely by the sulphur constituent of fertilizers. Pertaining to time of application, two split

Table 3 :Potassium uptake kg/hectare as influenced by Nitrogen and potassium sources and their time of application 30th, 60th, 90th DAT

Sources	30 DAT					60 DAT					90 DAT				
	T ₁	T ₂	T ₃	Mean		T ₁	T ₂	T ₃	Mean		T ₁	T ₂	T ₃	Mean	
S ₁	1.77	1.29	0.95	1.33		4.55	3.97	3.97	3.86		32.53	35.20	35.93	34.23	
S ₂	1.72	1.56	1.00	1.42		5.29	4.91	4.91	4.97		35.64	37.27	35.08	35.99	
S ₃	1.04	0.78	1.32	1.04		4.11	4.10	4.10	4.10		33.63	33.20	36.39	34.40	
S ₄	1.56	1.94	1.52	1.67		4.13	4.50	4.50	4.44		32.44	36.93	34.80	34.72	
Mean	1.52	1.39	1.19	-		4.01	4.37	4.37	-		33.56	35.65	35.30	-	
	F-TEST	SED±	CD	CV%		F-TEST	SED±	CD	CV%		F-TEST	SED±	CD		
Sources (S)	S	0.08	0.18	13.35		S	0.10	0.31	5.27		NS	-	-	5.15	
Time of Application (T)	S	0.07	0.15	-		S	0.04	0.38	-		S	0.73	1.52	-	
Interaction (S x T)	S	0.15	0.31	-		S	0.09	0.19	-		NS	-	-	-	

application of these sources of N and K was found to be statistically superior compared to single application and on par with three-split application at 60 DAT and 90 DAT. It indicated that the application of fertilizer in two splits was better than single and three split applications in relation to cost of production, nutrient use efficiency and growth of the crop. Among the interactions of sources of N and K fertilizer and time of application, S₂T₂ i.e.(ammonium sulphate + sulphate of potash in two split - 1/2 basal + 1/2 30 DAT) has registered the maximum uptake of potassium 5.29 kg ha⁻¹ and 37.27 kg ha⁻¹ at 60 DAT and 90 DAT, respectively. This interaction effect clearly confirming the results obtained by independent influence of ammonium sulphate + sulphate of potash as source and two split application as number of times of application. This could be due to the fact that 'K' available in the sources may be mostly soluble in water and available in exchangeable form.

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Effect of Plant Growth Regulators on Growth, Yield and Quality of Water-melon

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ABSTRACT

The effect of different levels of plant growth regulators viz., GA₃, NAA and 2,4-D on growth, yield and quality of summer watermelon was studied in the present investigation under South Gujarat conditions at Valsad district. The results revealed significant beneficial effects of GA₃-15ppm, GA₃-25ppm and GA₃-35ppm on the growth parameters viz., length of main axis, number of male and female flowers per plant, number of nodes for first female flower appearance, number of fruits per plant, average fruit weight, fruit yield/ha and quality (TSS%) of water melon, whereas NAA-10ppm and NAA-20ppm showed significant effect on number of branches per plant in water melon.

Key words : Plant growth regulators water - melon, GA₃, 2,4D, NAA, fruit yield, Quality TSS.

Watermelon is an important dessert (summer fruit) crop grown successfully on well drained soils of South Gujarat. Application of plant growth regulators has been reported to influence the growth, sex expression, fruit set and yield of watermelon (Rehm, 1952; Gopalakrishnan and Chowdhary, 1978). The present study was undertaken to investigate the effect of plant growth regulators on growth, sex expression, yield and quality of the water melon cv. Sugar baby which is extensively grown during summer in South Gujarat.

MATERIAL AND METHODS

The studies were undertaken at Paria in Valsad district of Gujarat state, in a randomized block design with three replications. The sowings were taken up in the first fortnight of January by dibbling three seeds/hill in rows at spacing of 2.5mx1.5m. Application of Gibberellic acid (10,20 and 30ppm); NAA (15,25 and 35ppm),

2,4-D (3,5 and 7ppm) and water spray (Control) was under taken twice at 2nd and 4-5 leaf stages of crop. Due care was taken to fully moisten the leaf surface and apical meristems. Observation on length of main axis, number of primaries, number of fruits per plant, single fruit weight, yield and total soluble solids were recorded following standard procedure and analysed as per the statistical procedures detailed by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Results of the present study on the effect of plant growth regulators on growth, sex expression, yield and quality of watermelon was presented in Table 1. The results revealed that maximum elongation of main axis (288mm) with GA₃ @ 35ppm followed by GA₃ @ 25ppm probably due to increased rate of photosynthesis, increased rate of translocation and efficiency of utilizing photosynthates resulting in cell

Table : Potassium uptake kg /hectare as influenced by Nitrogen and potassium sources and their time of application 30th, 60th, 90th DAT

S.No	Treatment	Length of main axis (cm)	No. of primary branches	No. of male flowers per plant	No. of female flowers per plant	Sex ratio (female to male)	No. of fruits per plant	Average fruit weight (Kg)	Yield (Q/ha)	TSS%
1	GA ₃ @15ppm	225	6.04	582	70.11	9.00	2.90	2.70	218.66	8.55
2	GA ₃ @25ppm	271	6.71	655	65.94	10.40	3.10	3.10	269.00	9.30
3	GA ₃ @35ppm	288	7.71	669	63.28	10.60	2.80	2.90	225.00	8.80
4	NAA @10ppm	203	8.85	538	74.16	8.10	2.50	2.80	189.00	8.60
5	NAA @20ppm	216	9.13	536	77.98	8.13	2.90	2.50	202.00	8.40
6	NAA @30ppm	224	7.83	522	73.73	7.80	2.80	2.30	184.00	7.00
7	2,4D @3ppm	198	5.94	529	72.26	10.30	2.90	2.50	200.00	7.30
8	2,4D @5ppm	192	5.62	584	67.95	8.60	2.50	2.50	173.00	7.10
9	2,4D @7ppm	185	5.23	568	67.13	8.30	2.40	2.20	150.00	7.00
10	Control (Water spray)	180	4.85	547	63.91	10.10	2.20	2.30	143.00	7.30
	SEM+	0.54	0.08	5.35	0.72	0.82	0.07	0.12	4.95	0.05
	CD@5%	1.55	0.25	15.20	2.06	0.23	0.02	0.34	25.11	0.14

elongation and rapid cell division in the growing portion (Phinney *et al.*, 1957). The results are in consonance with the findings of Randhawa and Kirti Singh (1975) and Arora *et al.* (1987 and 1988).

A significant improvement in the number of branches per plant was also observed with all growth regulators studied, compared to control. However, NAA @ 20ppm and 30ppm had recorded maximum number of branches per plant. This may be attributed to the growth promoting ability of NAA in plant tissue through increased RNA and protein synthesis. (Phinney *et al.*, 1957). The findings are also in conformity with the reports of Randhawa and Kirti Singh (1975). The application of 2,4-D had also resulted in greater length of main axis compared to the control, probably due to the softening of cell wall by the action of auxins, resulting in increased elasticity and growth stimulation (Tagawa and Bonner, 1957).

An increase in the number of male flowers, particularly at higher concentrations (25 and 35ppm) of gibberellic acid was also observed in the present study. Similar results were reported earlier (Gopalakrishnan and Chowdhary, 1978; Galun *et al.*, 1963). In contrast application of NAA (10 and 20ppm) had resulted in maximum number of pistillate flowers and low sex ratio, compared to other treatments. Singh and Singh (1984) had also reported more number of pistillate flowers with NAA application compared to control. Gopalakrishnan and Chowdhary (1980) also reported narrow sex ratios with the application of NAA in watermelon similar to the findings of the present study. Heslop-Harrison (1957) attributed it to the control of sexual differentiation by endogenous levels of auxins and favouring

of pistillate organs at high auxin levels in the vicinity of differentiating primordial.

Average fruit weight was observed to be maximum (3.10Kg) for GA₃ @ 25ppm followed by GA₃ 35ppm (2.90Kg), compared to control and other treatments studied. The beneficial effect of gibberellic acid on fruit weight may be explained in the light of the report of Crane and Overberk (1965) who suggested that sole function of fertilized ovules or seeds in relation to growth of fruit is to synthesize one or more hormones which initiate and maintain a metabolic gradient along which food can be translocated from other parts of plant towards *growing* fruit. The results are also in agreement with the reports of Arora *et al.*, (1985) in bottle gourd.

Application of growth regulators viz., GA₃, NAA and 2,4-D had also resulted in an increase in the yield levels by 4.9 to 88.1 per cent over the control. Among the different growth regulators studied, application of GA₃ had resulted in relatively higher yields (>215q/ha) compared to NAA and 2,4-D treatments. Further, application of GA₃ @ 25ppm had resulted in maximum yield (269 q/ha), compared to other treatments (15 and 35ppm) probably due to the greater number of fruits per plant recorded for the treatment. Similar results were reported earlier (Arora *et al.*, 1988).

Conclusions

The present study thus revealed that the beneficial effects of plants growth regulators on growth, yield and quality of watermelon cv. sugar baby. Application of GA₃ @ 25ppm had resulted in maximum number of fruits per plant, fruit weight and yield in addition to high total soluble salts. The treatment had resulted in 88% higher yields, 35% greater fruit weight, 41% greater

number of fruits per plant and 27% higher total soluble solids, compared to control, indicating its desirability in the commercial cultivation of summer water melon under South Gujarat conditions.

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Studies on Drymatter Accumulation and Grain yield in Hybrid Rice (*Oryza sativa* L.)

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ABSTRACT

In a field experiment the drymatter production and grain yield of rice cultivars were assessed during *rabi* season of 1996. Although cultivars MGR - 1 and KHR - 1 produced lowest amount of drymatter, the proportion of drymatter gone into reproductive structures was 52% whereas in other two high yielding hybrids (TNRH-16 and DRRH-1) the proportion was below 40%. The drymatter accumulated in mature rice plant is 14.35% in root, 9.34% in leaf, 31.21% in stem, 45.09% in reproductive structures. The drymatter in stem increased gradually upto 60 DAT and then decreased in all the cultivars indicating retranslocation of photosynthates even from the stem to the developing grains. Among the cultivars, TNRH-16 recorded maximum drymatter and grain yield of (23.28 g plant⁻¹ and 6470 kg ha⁻¹) followed by DRRH-1 (21.7g plant⁻¹ and 5750 kg ha⁻¹) respectively.

Key words : Drymatter, grain yield, Hybrid Rice

In a given environment the physiological performances like partitioning of drymatter and mineral elements to the economic product of different genotypes will indicate their involvement in contributing to higher yield. The high yield of hybrids was due to increased total drymatter due to high crop growth rate of 30 g m⁻² d⁻¹ for 30 days before heading in rice (Shanmugasundaram *et al.*, 1990). According to Yuan *et al* (1988) hybrid rice yields are 20-30% more than conventional varieties under adequate management. Yamuchi *et al* (1985) reported that F₁ hybrids accumulate more drymatter than their parents. Hence the present study was planned to study the drymatter accumulation and its contribution to grain yield of hybrid rice.

MATERIAL AND METHODS

A field experiment was conducted at wetland farm of S.V. Agricultural College Tirupati, Andhra Pradesh during *rabi* 1996. The soil was

sandy clay loam containing 211, 31.8, and 178 kg of available N, P₂O₅, and K, respectively. Rice hybrids MGR-1, KHR-1, APHR-2, NLR-33358 (check) TNRH-16 and DRRH-1 were sown in a randomized block design with four replications. The experimental plots were (4 m x 5 m) fertilized with 102, 60 and 45 NPK ha⁻¹. The seedlings were transplanted on 25th December 1996 with a spacing of 20 cm x 10 cm. Plant samples from an area of 0.5 m² were dug along with roots at 30 days interval starting from 30 DAS. The plants were separated into root, leaf, stem and panicles and were dried in a hot air oven at 100°C for 15 minutes and then at 80°C for 48 hours. The data on yield and yield components was recorded at harvest.

RESULTS AND DISCUSSION

There was a gradual increase in drymatter from 30 DAT to maturity in all the hybrids (Table1). At 30 DAT, KHR-1 recorded maximum

Table 1 : Drymatter accumulation and partitioning during plant growth (g/plant) in rice hybrids.

Cultivar	30 Days after transplanting					60 Days after transplanting					90 Days after transplanting				
	Drymatter partition (%)					Drymatter partition (%)					Drymatter partition (%)				
	TDM (g/plant)	Root	Leaf	Stem	TDM (g/plant)	Root	Leaf	Stem	Grain	TDM (g/plant)	Root	Leaf	Stem	Grain	TDM (g/plant)
MGR-1	2.75	13.82	42.18	44.00	9.55	22.09	16.86	45.97	15.08	15.10	14.24	9.60	24.44	51.72	15.10
APHR-2	2.60	16.93	41.92	41.15	10.83	32.59	16.82	38.04	12.75	17.17	12.58	9.03	30.69	47.70	17.17
KHR-1	3.90	18.72	31.79	49.49	11.18	29.87	16.73	41.24	12.16	15.48	14.40	9.24	25.26	51.10	15.48
NLR 33358	2.41	21.16	37.76	41.08	13.18	24.28	15.55	53.03	7.14	19.35	16.02	7.90	33.13	42.95	19.35
TNRH-16	2.23	16.14	37.22	46.64	12.71	27.62	21.48	48.47	2.43	23.28	12.71	10.40	39.3	37.59	23.28
DRRH-1	2.25	18.67	48.0	33.33	11.64	28.52	15.89	52.84	2.75	21.79	16.15	9.87	34.47	39.51	21.79

total drymatter (3.99 g plant⁻¹) while NLR 33358 and TNRH-16 recorded maximum TDM (13.18 g and 23.28 g plant⁻¹) at 60 and 90 DAT, respectively. The partitioning of drymatter towards stem is more (41-49%) compared to leaf (37-42%) in all the hybrids at 30 DAT. The drymatter accumulation in stem is increased upto 60 DAT and then showed a decrease in all the cultivars indicating retranslocation of photosynthates even from the stem to the developing grains. At low nitrogen levels, large amount of carbohydrates accumulated in the vegetative parts before heading and contribute substantially to the grain carbohydrate (Yoshida and Ahn, 1968). TNRH-16 recorded highest drymatter accumulation in stem compared to other cultures. The leaf drymatter accumulation was decreased from 60 DAT. The fall in leaf phytomass during subsequent stages of growth may be due to translocation of photosynthates to the developing grains. In rice all the leaves from the flag leaf down to the third leaf from the top export assimilates to the panicle (Tanaka, 1958). It is desirable to have higher drymatter content in leaves at the time of grain filling stage to obtain maximum yields. Among the hybrids TNRH-16 maintained high leaf dry weight (10.4%) at grain filling stage and hence it produced maximum grain yield.

Total dry matter that can be produced and its further translocation to sink is the major factor that governs the economic performance of a variety. Higher drymatter production in TNRH-16 than other cultivars can be attributed to more LAI, LAD and better growth rates recorded with this hybrid. Similar increment in drymatter in case of hybrids over check varieties was reported by IRRI (1989). Although cultivar MGR-1 and KHR-1 produced the lowest amount of drymatter the

Table 2 : Yield and Yield components in rice hybrids

Character	Cultivars						CD at 5%
	MGR-1	APHR-2	KHR-1	NLR 33358	TNRH-16	DRRH-1	
Grain yield Kg ha ⁻¹	4775.0	5362.5	5062.5	4627.5	6470.0	5750.0	946.00
Panicles m ⁻²	315.6	325.4	322.2	294.5	340.1	329.5	NS
No. of filled grains panicle ⁻¹	91.03	103.53	101.34	80.02	110.0	106.5	3.2
1000-grain weight (g)	22.33	21.81	22.30	22.10	22.50	21.90	0.09
Harvest index (%)	62.95	62.79	65.40	47.70	55.27	53.11	-

proportion of drymatter gone into reproductive structure was 52% where as in other two high yielding hybrids (TNRH-16 and DRRH-1) the proportion was below 40%. This suggests that hybrids MGR-1 and KHR-1 had good partitioning ability towards the reproductive structures. The present study confirms views of Fisher and Turner (1978) that the genotype exerts major control over partitioning. The drymatter accumulated in matured rice plant was 14.35% in root, 9.34% in leaf, 31.21% in stem and 45.09% in reproductive structures.

The maximum grain yield was obtained with TNRH-16 (6470 kg ha⁻¹) followed by DRRH-1 (5750 kg ha⁻¹) (Table 2). Rest of the cultivars have given yield within a range of 4627 to 5062 kg ha⁻¹. The yield difference in the six cultivars were due to the significant differences in yield components. TNRH-16 recorded more no. of filled grains per panicles (110), 1000 grain weight (22.5 g) and no. of panicles per m² (340) while the check variety NLR 33358 recorded lower no. of filled grains per panicle (80) and no. of panicles per m² (294). Grain yield mainly depends on no. of filled grains per panicle and weight of grain. This shows better yield potential of hybrid over check. Rao *et al.*, (1985) also found similar differences

in yield potential between hybrids and local check. Harvest index reflects the physiological capacity of a crop to mobilize and translocate photosynthates (Sink capacity) to organs having economic value. Higher harvest index was with hybrid rice KHR-1 (65.4%) compared to check varieties (47%). Similar results were reported by IRRI (1990). From the present investigation it can be concluded that among the rice hybrids TNRH-16 had higher total drymatter and grain yield.

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***In vivo* Fortification of Zinc in Rice (*Oryza sativa* L.)**

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ABSTRACT

A pot culture experiment was carried out during *rabi* 2002-2003 at Department of Plant Physiology, Agricultural College, Bapatla to study the effect of zinc foliar spray on yield and yield components and zinc accumulation in leaf, stem and kernel in Cv. MTU 1001 (at 0.25%, 0.5%, 0.75%, 1% foliar spray of ZnSO_4 and soil application @ 50kg ha⁻¹ along with control). Rice cultivar MTU 1001 performed better at 0.5% Zn foliar spray and resulted in more number of productive tillers-hill⁻¹, number of filled grains panicle⁻¹ test weight and grain yield. Foliar application of zinc enhanced the accumulation of Zn in leaf, stem, brown and polished rice. The accumulation was more in brown rice compared to polished kernels.

Key Words : Zinc, Rice

Rice (*Oryza sativa* L.) is the major source of food for nearly half of the world population. Rice grain is rich in minerals (0.6%) but the rice bran contains more minerals (6.6%) than other parts of the grain (Gopalan *et al.*, 1971). During milling, most of these nutrients are lost (Sotelo *et al.*, 1990, Liu Zianhu and Liu, 1995). The new thinking in the area of Zn nutrition is that neither uptake nor translocation contributes much to the Zn efficiency. On the other hand, biochemical utilization in shoot is the key-regulating factor (Hacisalihoglu *et al.*, 2004). Thus, if iron and zinc content of rice grain could be advanced the health of the people could be dramatically improved. Most of the victims are being impoverished women and children of which many are in Asia. Their limited diets primarily comprise one basic food: rice, rice and more rice.

MATERIAL AND METHODS

A pot culture experiment was conducted at Department of Plant Physiology, Agricultural College, Bapatla during the year 2002-2003 to

find the optimum level of Zn supply through foliar spray and through soil application in completely randomized block design (CRBD) with four replications.

Treatments:- 5 levels of Zn spray (0, 0.25, 0.50, 0.75 and 1% ZnSO_4) at 50% flowering stage and another a week after and one soil application 50 kg ha⁻¹ ZnSO_4 as basal.

RESULTS AND DISCUSSION

Effect of Zn foliar spray on leaf, stem and kernel mineral concentration

The zinc concentrations in leaf, stem and rice kernels significantly increased from control to 1 per cent foliar spray.

Foliar spray of 1.0 per cent zinc exhibited a significant supremacy in its accumulation upto 52.51ppm in leaf, 70.26ppm in stem, 35.70 in dehusked rice and 29.05ppm in polished rice. The enhancement over control was 33.61% in leaf, 13.87% in stem, 36.10% in dehusked rice and 33.62% in polished rice.

Table 1 : Effect of ZnSO_4 foliar spray on zinc content (ppm) on leaf, stem, dehusked and polished kernels of rice Cv MTU 1001

Concentration of ZnSO_4	Leaf	Stem	Dehusked rice	Polished rice
Control (T_1)	39.30	61.70	26.23	21.74
0.25% (T_2)	42.75 (8.78)	62.71 (1.64)	28.92 (10.26)	23.14 (6.44)
0.5% (T_3)	45.40 (15.52)	64.17 (4.00)	30.14 (14.91)	25.65 (17.99)
0.75% (T_4)	49.25 (25.32)	68.08 (10.34)	32.15 (22.57)	27.28 (25.48)
1.0% (T_5)	52.51 (33.61)	70.26 (13.87)	35.70 (36.10)	29.05 (33.62)
Soil application (T_6) (50 kg ha^{-1}) as basal	45.82 (16.59)	63.67 (3.19)	30.20 (15.14)	24.83 (14.21)
SE	0.85	0.60	1.18	0.57
LSD (0.05)	2.53	1.80	3.52	1.71
CV(%)	3.71	1.86	6.82	4.61

From the data present in the table 1, it can be inferred that the highest accumulation occurred in 1.0 per cent spray, whereas, soil application and 0.5% per cent spray were quite similar in accumulation of zinc. The cultivar MTU 1001 registered maximum accumulation at 1.0 per cent spray in case of brown rice (35.70ppm) and in case of polished rice (29.05ppm) kernels, respectively. This increase might be due to increased availability of zinc through foliar spray (Sakal and Singh, 1982).

Yield components and yield

Foliar spray of Zn increased number of productive tillers from control to 0.5 per cent and soil application but highest increase was only with 0.5 per cent spray (11.02) as presented in table 2. This increase might be due to increased

photosynthetic rate, excessive accumulation of sucrose, glucose and fructose in leaves (Rai and Singh, 1981). Zinc application increased the number of filled grains at 0.5 per cent spray. As zinc plays a role in chlorophyll synthesis, the higher chlorophyll content might have lead to faster grain filling through increased photosynthetic rate (Padmaja Rao *et al.*, 1985) spikelet sterility was greatly reduced with 0.5 per cent Zn spray. It could be evident from these observations that Zn might have enhanced the translocation of assimilates which reflected on decreasing sterility per cent. However, there was less reduction at 0.75 and 1.0 Zn spray. The depressive effect of zinc toxicity on grain filling was also reported by Ajay and Rathore (1995).

Table 2 : Effect of ZnSO₄ foliar spray on yield components and yield of rice Cv MTU 1001

Concentration of ZnSO ₄	Total No. of tillers hill ⁻¹	No. of productive tillers hill ⁻¹	No. of filled grains panicle ⁻¹	Spikelet sterility (%)	1000 grain weight (g)	Grain yield (g hill ⁻¹)
Control (T ₁)	14.86	9.03	111.4	22.5	22.78	18.62
0.25% (T ₂)	15.04 (1.21)	10.49 (16.17)	114.7 (2.96)	20.07 (-10.8)	22.94 (0.70)	19.34 (3.87)
0.5% (T ₃)	15.38 (3.50)	11.02 (22.04)	117.1 (5.12)	18.98 (-15.64)	23.01 (1.01)	19.50 (4.73)
0.75% (T ₄)	14.57 (-1.95)	9.01 (-0.22)	108.00 (-3.05)	22.13 (-1.64)	22.25 (-2.33)	18.07 (-2.95)
1.0% (T ₅)	14.14 (-4.85)	8.77 (-2.88)	106.2 (-4.47)	23.21 (3.16)	22.12 (-2.90)	16.19 (-13.05)
Soil application (T ₆) (50 kg ha ⁻¹) as basal	15.36 (3.36)	10.88 (20.49)	115.9 (4.04)	19.18 (-14.76)	22.96 (0.79)	19.43 (4.35)
SE	0.31	0.13	0.82	0.26	0.44	0.15
LSD (0.05)	NS	0.39	2.46	0.78	NS	0.46
CV(%)	4.25	2.66	1.47	2.51	3.89	1.69

(Values in the parenthesis are per cent increase or decrease over control)

Application of Zn had no significant influence on test weight. Application of Zn gave a significant enhancement in grain yield. The increased yield with Zn spray was through enhanced yield components viz., number of productive tillers, number of filled grains panicle⁻¹ decreased spikelet sterility and faster grain filling (Singh and Sharma, 1994) and also due to biochemical utilization of zinc in the shoot (Hacisalihoglu *et al.*, 2004).

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Studies on Seed Germination and Other Seed Related Traits in Various Guava (*Psidium guajava* L.) Accessions

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ABSTRACT

Soaking seeds in HCl 35%, H_2SO_4 35% for 3 minutes and in Giberellic Acid (GA_3) 1000 ppm for 24 hours significantly improved germination while boiling for 3 minutes completely reduced germination in various guava accessions. Accessions viz., White Flesh and Dharwad showed higher germination with GA_3 treatment whereas the rest of the accessions with HCl treatment. Further, the observations on some of the seed related traits like seed weight, seed number and average seed bearing portion showed considerable degree of variation among the accessions.

Key Words : Seed treatment, Seed germination, Accessions, Guava

Guava (*Psidium guajava* L.) is an important fruit crop of India. It has gained considerable importance due to its high nutritive value, hardy nature and availability at moderate price. Although numerous asexual methods have been advocated for quick propagation in guava (Srivastava, 1964), for raising rootstocks and hybrids, seeds have to be sown. The germination of guava seeds is uncertain due to hard seed coat (Singh, 1967). Different seed treatments like water soaking (Rodriguez *et al.*, 1985), ethrel and sulfuric acid (Sinha *et al.*, 1973) have been found to improve the germination in guava but not much information is available on the accessions selected for present study. Hence, a study was taken up to find the response of various guava accessions to different seed soaking treatments.

Most of the guava varieties commercially grown in India are selections of superior seedlings resulting from sexual propagation (Chadha, 1998). Fewer seeds/fruit was considered as a selection trait in selection of seedling progeny

S-1 (Singh, 1959) and S-8 viz., *Arka mrudula* (Iyer and Subramanyam, 1988) in guava. In the present investigation also, attempts were made to find out variation in the accessions with respect to some seed related traits.

MATERIAL AND METHODS

The study was conducted at Indian Institute of Horticultural Research, Bangalore, during 2002-2003. For seed germination studies, healthy guava seeds extracted from fully ripen fruits of various accessions were taken. The treatments included soaking seeds in HCl 35%, H_2SO_4 35%, boiling water for 3 min and Giberellic Acid (GA_3) @ 1000 ppm for 24 h prior to sowing. One set of seeds without any treatment was kept as control. Experiments were arranged as Factorial Randomized Block Design and consisted of 3 replicates of 50 seeds each. The seeds were sown in plastic protrays filled with 2 parts of soil, 1 part of sand and 1 part of FYM. During the entire period of experimentation, the optimum moisture level was maintained to facilitate germination. Percentage germination

Table 1 : Seed germination as influenced by different soaking treatments in various guava accessions. (Values in brackets represent angular transformed values)

Accessions/ Treatments	Surka chitti	Behat coconut	Nasik	G-6	White flesh	Benaras	Mirzapur seedling	Lucknow - 42	Dharwad	Mean
Control	29.0 (32.5)	18.0 (25.1)	28.0 (31.9)	18.0 (25.1)	13.0 (21.1)	23.0 (28.6)	11.0 (19.2)	16.0 (23.5)	9.0 (17.4)	24.9
GA₃(1000ppm)	30.0 (33.2)	18.0 (25.1)	28.0 (31.9)	26.0 (30.6)	19.0 (25.8)	43.0 (41.0)	22.0 (27.9)	46.0 (42.7)	46.0 (42.7)	33.4
HCl -35%	56.0 (48.4)	42.0 (40.4)	71.0 (57.4)	63.0 (52.5)	13.0 (21.1)	54.0 (48.3)	52.0 (46.2)	68.0 (55.5)	37.0 (37.4)	45.2
H₂SO₄ - 35%	40.0 (39.2)	46.0 (42.7)	33.0 (35.0)	36.0 (36.8)	15.0 (22.7)	33.0 (35.0)	34.0 (35.6)	54.0 (47.3)	10.0 (18.4)	34.8
Boiling	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0
Mean	30.7	26.6	31.3	29.0	18.1	30.6	25.8	33.8	23.2	27.7
C.D (P=0.05)										
Accessions (A) 1.47										
Treatments (B) 1.09										
AxB 3.28										

values were analyzed by ANOVA after subjecting to angular transformation and means were compared using Critical Difference. For other parameters, viz., thousand seed weight (g), number of seeds/fruit, fruit to seed ratio and average seed bearing portion, data recorded for a period of two years with three replications in nine accessions was pooled and the pooled mean was subjected to statistical analysis.

RESULTS AND DISCUSSION

Effects of treatments

All the treatments included in the study significantly increased germination when compared to control, except boiling of the seeds. Soaking seeds in boiling water for completely reduced the germination when compared to

control (Table 1). Boiling seeds for 3 min have caused the lethal effect and terminated the viability. Ramachandra and Sheogovind (1990) also reported similar results in guava. Among various treatments, the treatment with HCl for 3 min followed by H₂SO₄ for 3 min gave higher germination. These treatment resulted in 20.3% and 9.9% more germination over control, respectively. Similar observations were also made by Rahman and Quadir (1989) in guava. Singh and Soni (1974) found that acid treatment made the seeds permeable and enhanced their germination in guava. However, for the same duration and concentration, the significant differences between HCl and H₂SO₄ treatment effects may be due to variation in effect of individual ions viz., Cl⁻ and SO₄⁻ ions as noticed

Table 2 : Seeds related traits of various guava accessions studied

Accession	1000 seed weight (g)	No.of seeds/ fruit	No.of seeds/ kg	Fruit/ seed ratio	Average seed bearing portion
Surka chitti	11.3	112	2201	133.8	3.81
Behat coconut	9.20	109	925	109.1	3.70
Nasik	6.84	192	2091	42.98	3.45
G-6	6.45	179	1135	81.67	3.00
White flesh	8.48	220	1929	61.22	3.17
Benaras	6.97	343	2360	60.20	3.97
Mirazapur seedling	9.80	225	1293	78.92	3.56
Lucknow-42	10.2	119	822	120.3	3.70
Dharwad	7.80	125	1195	99.08	3.62
C.D.(P=0.05)	0.574	10.61	103.25	5.90	0.142

by Pandey and Singh (2000). Soaking in GA_3 @ 1000 ppm for 24 h also increased germination over control to the extent of 8.5%. Mathur *et al.*, (1971) attributed such increase in germination to diffusion of endogenous auxins and gibberellins like substances.

Effect of Accessions

Wide variation in per cent germination was noticed among the Accessions. Lucknow-42 showed maximum germination (33.8%), which was significantly higher over all other accessions. The per cent germination in Nasik, Surka chitti and Benaras was on par. Among the accessions, White flesh recorded minimum germination (18.1%). This kind of variation in accessions with respect to seed germination might be due to differences in their seed coat permeability to gases or presence of inhibitory substances (Table 1).

Interaction effects

Marked differences were observed in

interaction effects. All the accessions showed maximum germination in combination with HCl, except White flesh and Dharwad. In case of White flesh, higher germination was obtained with GA_3 treatment. Similarly, accession Dharwad also showed higher germination with GA_3 treatment and it was significantly more to the extent of 25.3, 10.3 and 24.3% over control, HCl and H_2SO_4 , respectively. In case of Behat coconut and White flesh, the effect of HCl on per cent germination was same as that of H_2SO_4 . Among various interactions, the interactions *viz.*, Nasik x HCl and Lucknow-42 x HCl resulted in higher germination (Table 1).

Comparison of seed related traits

Significant difference ($p=0.05$) was noticed among accessions for all the seed related traits studied (Table 2). Less number of seeds per fruit (Chadha, 1998), average seed bearing portion and higher fruit/seed ratio are some of the desirable characters in selection of parents

Table 3 : Mean range and coefficient of variation for seed related traits in guava accessions.

Character	Range	Mean	S.D	CV%
1000 seed weight	6.45-11.25	8.56	1.67	19.51
No.of seeds/fruit	109-343	180.43	76.44	42.37
No.of seeds/kg	822-2360	1550.20	591.60	38.16
Fruit/seed ratio	42.98-133.8	87.48	30.31	34.64
Average seed bearing portion	3-3.97	3.55	0.31	8.73

for crop improvement programme. In the present investigation, Behat coconut (109.23) followed by Surka chitti (112) and Lucknow-42 (119) showed lesser number of seeds/fruit. The fruit to seed ratio was more in Surka Chitti (133.87) followed by Lucknow-42 (120.28) and Behat coconut (109.11). The average seed bearing portion was in the range of 3-3.97 in various accessions and it was on par in Surka chitti, Behat coconut and Lucknow-42. Thousand seed weight was 6.45-11.25 g in different accessions with highest value in Surka chitti followed by Lucknow-42. However no significant differences were observed either between G-6 and Nasik or Nasik and Benaras for this character (Table 2). A perusal of the data in Table 3 shows considerable degree of variation with respect to seed related traits. The biggest coefficient of variation (CV) was noticed for number of seeds/fruit (42.37%) and the lowest for average seed bearing portion (8.73%). Since, the traits showed wider variability, they might be used to make selections in guava.

Conclusion

Soaking seeds in HCl 35%, H₂SO₄ 35% and GA₃ @ 1000ppm significantly improved germination in guava over control. Accessions viz., White flesh and Dharwad showed higher germination when treated with GA₃ whereas the rest of the accessions with HCl treatment. Considerable variation noticed in seed related traits could be exploited for future breeding programme.

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Ergonomic Evaluation of Engine Operated Rotary Grass Cutter

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ABSTRACT

Women labourers generally cut grass with sickle. Hand pulled or hand pushed cutters are limited to lawns only. An Engine operated grass cutter has been developed and being used at College of Agril. Eng., Bapatla. This machine has been ergonomically evaluated in comparison with the sickle. Grass Cutting by sickle required a heart rate of 99 to 151 beats/min and classified as moderate to heavy, where as grass cutting by Engine Operated Rotary Grass Cutter required heart rate of 100 to 118 beats/min and classified as moderate. The mid day operations required more heart rate. Age and experience also influenced the heart rate

Key words : Evaluation - Engine Operated Rotary Grass Cutter.

Grass is an unwanted weed in the croplands, in forest areas, orchards and in social forests. Women of that area cut this grass either for feeding animals left on the farm as unwanted weed. Sickle is common implement used by the labourers. The hand pulled or pushed grass cutters are available but their use is limited to lawns only. Helical cutters are generally employed in them. Use of tractor operated rotary shredders is a rarity. An engine operated rotary grass cutter has been developed and is being used at College of Agricultural Engineering College, Bapatla. Male labourers operate it. It is felt that the grass cutting by women labour is time consuming and results in less turn over, whereas machine operation is heavy and drudgery. The work heaviness during the operation is evaluated through heart rate measurement.

Sujit Chowdary (1988) stated that normal workable heart rate is 50 -100 beats per minute. Saha *et al.*, (1979), observed that maximum workable heart rate for a healthy person is 190

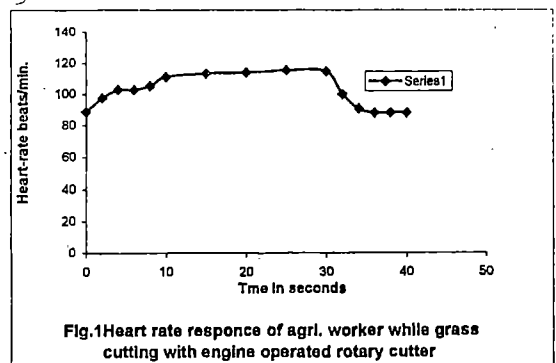


Fig.1 Heart rate response of agri. worker while grass cutting with engine operated rotary cutter

beats per minute. Christensen (1953) classified the work based on pulse rate as

Pulse rate beats/min.	Work classification
>175	maximal
150 -175	very heavy
120 - 150	heavy
100 - 120	moderate
<100	light

An experiment to evaluate ergonomically the engine operated rotary grass cutter in comparison with sickle has been conducted with two treatments

Table 1 : Maximum heart rate of the operator during grass cutting by sickle and Engine operated rotary cutter as influenced by age-group and temperature or timings

Grass Cutting By Sickle						Grass Cutting By Engine Operated Rotary Cutter					
Age Group	Maximum Heart rate					Maximum Heart rate					
Years	Morning	mid day	Evening	Average heart rate	Classification	Morning	Mid day	Evening	Average heart rate	Classification	
20 - 30	28°C	42°C	37°C			24°C	39°C	29°C			
30 - 40	134.7	150.7	128	137.8	Heavy	114.7	128	110.7	117.8	Moderate	
> 40	120	130.7	122.7	124.5	Heavy	105.3	110.7	106.7	107.5	Moderate	
Average heart rate	99	120	106.7	108.5	Moderate	100	104.7	104	102.9	Moderate	
	117.9	133.8	119.1	123.6		106.7	114.5	107.2	109.4		

1. Engine operated rotary grass cutter

2. Sickle

and with sub-treatments

a) 3- age groups 20-30, 30-40, >40 years and

b) Three timings morning, mid-day, and evening

METHODOLOGY

During the operation the temperature was measured with a thermometer, humidity with a hygrometer and time with a stopwatch. In absence of the sophisticated instruments the heart rate was measured with doctor's stethoscope. The heart rate was measured before the commencement of operation and at every 2 minutes of operation upto 10 minutes and at every 5 minutes till the operator attains maximum heart rate. At every point the heart rate was taken 3 times and averaged. According

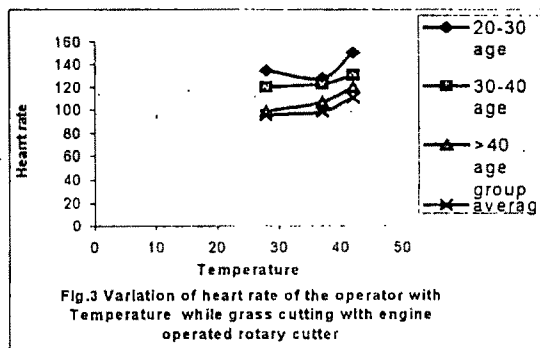


Fig.3 Variation of heart rate of the operator with Temperature while grass cutting with engine operated rotary cutter

to Eastman Kodak Company (1986),

The maximum workable heart rate = $220 - \text{age}$

The per cent Heart rate reserve (%HRR) = $\frac{(\text{working heart rate} - \text{resting heart rate}) \times 100}{(\text{Maximum workable heart rate} - \text{resting heart rate})}$

RESULTS AND DISCUSSION

The heart rate of the machine operator has increased from 88.4 beats/min to 115.1 beats/min. up to 30 minutes in a polynomial way and attained constancy following the equation $Y = -0.0492x^2 + 2.1967x + 91.735$ with $R^2 = 0.9514$. After the work is stopped and heart rate decreased up to 88 following the equation is $y = 1.9764x^2 - 18.75x + 130.54$ with $R^2 = 0.9843$

Grass cutting by sickle required a heart rate of 99 to 151 beats/min and classified as moderate to heavy, where as grass cutting by engine operated rotary harvester required heart

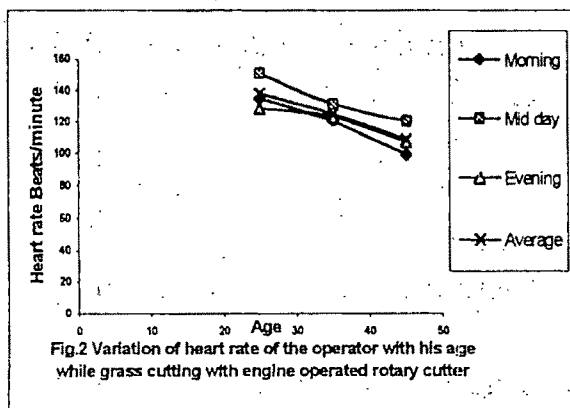


Fig.2 Variation of heart rate of the operator with his age while grass cutting with engine operated rotary cutter

Table 2 : % Heart Rate Reserve (HRR) of The Operator During Grass Cutting by sickle and Engine operated Rotary grass Cutter

Age Group in Years	With Sickle				With Engine Operated Rotary Grass Cutter			
	Morning	mid day	Evening	Average	Morning	mid day	Evening	Average
	28°C	42°C	37°C		28°C	42°C	37°C	
20 - 30	46.5	60.7	41.0	56.1	24.4	29.0	20.8	24.6
30 - 40	40.7	47.8	41.7	43.4	24.4	29.2	25.6	26.4
> 40	32.2	52.4	40.3	43.6	23.2	27.7	28.7	26.5
	39.8	53.6	41.0	47.7	24.0	28.6	25.0	25.8

rate of 100 to 118 beats/min and classified as moderate operation.

Grass cutting by sickle by persons of 20 to 30 age group required more heart rate compared to other age-group persons. This might be because of inexperience. The operation is classified as heavy in case of sickle where as it is moderate in case of machine. The same trend is observed with persons of 30 to 40 years of age group, both with sickle and machine. Persons of more than 40 years age group required minimum heart rate both with sickle and with machine. In all the cases the operation is termed as moderate.

The heart rate is found to vary with the age of the person in relation

$$\text{Heart rate} = -1.466 \times (\text{age}) + 174.89$$

$$\text{And } R^2 = 0.9973$$

In all the cases the mid-day operation require the highest heart rate whereas it is lower in the morning and in evening. The mid-day operation with sickle is heavy but it is moderate in case of rotary cutter.

The relation between the heart rate and the temperature is observed to be

$$\text{Heart rate} = 1.0182 \times (\text{temp}) + 65.269$$

$$\text{With } R^2 = 0.781$$

The capability of doing further work is indicated by the Heart Rate Reserve (HRR). This

is observed to be more with the 20-30 age group persons compared to other age group persons.

Conclusion

The ergonomic evaluation denotes the operation with engine operated grass cutter to be as moderate whereas, it is moderate to heavy with sickle

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An Opinion Study of Farmers Affected by Construction of Lower Manair Dam in Karimnagar Dt. of A.P.

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ABSTRACT

An ex post facto research design was followed to study the opinion of farmers whose lands were submerged due to construction of Lower Manair Dam in Karimnagar dt. of A.P. The sample size consisted of 120 farmers from 12 villages selected randomly ie; 10 farmers from each village. Majority of the farmers were middle age, illiterate, small farm category and had medium economic motivation. Majority of farmers opined that although the compensation amount was fixed as per the registration value, malpractices had occurred in payment of compensation. However, most of them agreed that construction was useful to farmers beside supplying drinking water and generating employment opportunities to local people.

Key words : Consturction, Lower Manair Dam

The Lower Manair Dam (LMD) was constructed in Karimnagar district of A.P. in order to use large quantities of run off water effectively and cater to the needs of farmers irrigating more than 1400 acres of land. But on the other side, due to its construction 12 villages submerged completely and 4 partially and with a result of 2000 farmer families lost their land and occupation and left completely shaken. Compensation was fixed and paid, but not to satisfaction of many. In the light of the above a study was conducted with the following objectives.

Objectives

1. To study the opinion of the farmers whose land was submerged during the construction of the Lower Manair Dam.
2. To know the relationship between independent variable and opinion of farmers towards the construction of Lower Manair Dam.

MATERIAL AND METHODS

The study was conducted in Karimnagar district (A.P.) purposively, since the dam was constructed in the district and many people were effected due to the construction of the dam. A total of 120 respondents from 12 villages were selected at random for the study. The frequency, percentages and correlation co-efficient was done to know the relationship between opinion of farmers towards the construction of the dam.

RESULTS AND DISCUSSIONS

It is evident from the table-1 that all respondents (100%) agreed that the compensation was paid as per registration value fixed by the authorities, but malpractices did occur in determination and compensation to the effected. Majority (95.83%) of them felt the construction of the dam was not beneficial to the submerged farmers and this could be because the payments were not given to them as decided.

Table 1 : Distribution of respondents based on opinion towards Lower Manair Dam.

S.No.	Category	Agree		Disagree	
		F	%	F	%
1.	The construction of Lower Manair Dam is useful to the farmers in ayacut area.	112	93.3	8	6.67
2.	Lower Maniar dam supplies drinking water to the residents of the neighbouring dist. (Warangal)	94	78.33	26	21.67
3.	Construction of LMD is not beneficial to the submerged farmers.	115	95.83	5	4.17
4.	Through the sumerged farmers lost their:				
	a) Land/house in LMD. They were given reasonable compensation.	4	3.33	116	96.67
	b) There were many malpractices in the determination and payment of compensation.	120	100	—	—
	c) Compensation amount was decided as per the registration value.	120	100	—	—
	d) Some of the compensation amount is yet to be paid to some of the submerged farmers.	118	98.34	2	1.66
5.	LMD is more costly compare to the benefits from it.	40	33.34	80	66.66
6.	During construction of LMD many labourers has got employment in LMD office.	89	74.17	112	93.33
7.	Qualified submerged farmers were given permanent employment in LMD office.	8	6.67	112	93.33
8.	Drainage problem of agril. land have increased.	20	16.67	100	83.33

Table 2 : Correlation Co-efficient between opinion and independent variables.

S.No.	Independent Variables	'r' Values
1.	Age	-0.1355 NS
2.	Education	0.5109**
3.	Compensation	0.2492**
4.	Size of land holdings (Before project)	0.2791**
5.	Size of land holdings (After project)	0.2056*
6.	Social participation	0.1309 NS
7.	Extension contact	0.1872 NS
8.	Experience in farming	-0.0674 NS
9.	Economic Motivation	0.0600 NS
10.	Management orientation	0.658 NS

* Significant at 0.05 level of probability.

** Significant at 0.01 level of probability.

NS - Non significant

Similarly majority (93%) had opined that the construction of the dam is useful to farmers in ayacut areas, besides the majority (78.3%) agreeing that the dam is useful in supplying drinking water to the people of adjacent district followed by 74 per cent had expressed that many labourers got employment opportunities by its constructions and this is quite natural that the huge dam constructed with an estimated budget of 70.25 crores.

From the investigation, it was revealed that majority of them belonged to middle age, small farmers category, illiterates, had taken compensation between Rs. 10,000 to 20,000/- and that they did not have neither active social participation nor extension contact. But, however, they had good experience in farming,

high economic motivation and under medium management orientation.

From the Table-2 it is evident that age and experience in farming were negative as they are supplementary to each other and indicated that respondents were well placed in age and experience in farming, they had no chance to utilize these due to the reduced size of land underdeveloped resources like irrigation wells. Social participation, Economic motivation and Management orientation were positive if not significant indicating that newly settled farm, home and village conditions, did not give much scope to these variables to operate. The size of the land holding before and after project was significant, clearly indicates that difference respectively rather reduced the size of the land

holding due to construction of the dam. Similarly, the education and compensation were significant and the opinion expressed towards compensation were significant and the opinion expressed towards compensation in the Table-1 is differing with that of in Table-2 and this clearly indicated the yawning difference between the market values expected by respondents and registration value paid by project as compensation.

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Socio-Economic Changes Among Beneficiary Farmers Due to Operational Research Project on Drainage and Water Management for Control of Soil Salinity

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ABSTRACT

The study was carried out in Prakasam district of Andhra Pradesh with the objective to study the Socio-Economic changes among beneficiary farmers due to Operational Research Project on drainage and water management for salinity control. It was found that the mean scores of family expenditure as a whole with its sub items viz., food, clothing, medicines, education, electricity, foot ware, recreation, fuel etc., indebtedness, increase in crop yields, returns on crops and increase in land value were statistically significant before and after the execution of Operational Research Project.

Key words : Socio-Economic, Beneficiary Farmers, Operational Research

India after independence with its care and concern for natural resources, could create stable societies with socio-economic development of people, rather than nomadic life, seen in the past. Ever increasing population and demand for food has become imperative to intensify the cultivation to match with technological advancement, which resulted in exploitation of natural resources ignoring the serious consequences on environment in the long run. The continued degradation of natural resources, off sets the agriculturally dependent economy. The socio-economic and ecological consequences are more immense and further deteriorates life standards. The ever increasing pressure on land and water resources, much of the irrigation command areas are being salinised, due to impeded drainage and high ground water table. In coastal areas, excessive exploitation of ground water has caused sea water intrusion resulting in worsening

of salinity problems. Realising the efficacy of reclamation measures and need for dissemination of reclamation technologies, an Operational Research Project on drainage and water management was implemented in Prakasam district of Andhra Pradesh to improve the socio-economic conditions of farming community, through application proper soil and water management practices. Socio-Economic changes referred to as the direct and indirect consequences experienced by the respondents as a result of participation in Operational Research Project activities. With this background, the present investigation was carried out with an objective to study the socio-economic changes among beneficiary farmers before and after implementation of the Operational Research Project on drainage and water management for salinity control.

Table 1 : Socio-Economic Changes Among Beneficiary Farmers Due to Operational Research Project.

Item	Before the Project		After the Project		t' value
	Mean	S.D	Mean	S.D	
1. Family expenditure (Rs/Annum)	25,411	9,881	38,566	16,703	11.17**
a) Food	17,069	6,320	22,815	8,547	14.57**
b) Clothing	2,698	1,275	4,211	2,003	14.69**
c) Medicines	859	950	1,536	1,761	5.54**
d) Education	2,617	3,371	6,244	10,247	4.04**
e) Electricity	667	473	1,190	672	15.22**
f) Foot ware	283	204	465	312	10.88**
g) Recreation	358	722	674	870	5.77**
h) Fuel	860	664	1,431	989	10.51**
2. Indebtedness (Rs)	12,833	19,496	22,851	29,937	2.30**
3. Increase in crop yields (kg/ha)	3,300	1,449	5,167	1,030	19.16**
4. Returns on crops (Rs/ha)	13,591	5,974	31,045	10,198	21.67**
5. Increase in land value (Rs/ha)	63,147	41,653	1,67,882	60,121	22.83**

** Significant at 0.01 level of probability

MATERIAL AND METHODS

An evaluative research design was used in conducting the research study, since it was related to the effectiveness of the project. The investigation was carried out in Uppugunduru and Konanki Villages of Prakasam district of Andhra Pradesh purposively, where the Operational Research Project was in operation. Total population of eighty - five beneficiary farmers were selected purposively, out of which 45 were in Uppugunduru and 40 were in Konanki of project implemented villages.

The data were collected through a structured comprehensive interview schedule developed on various aspects of study before and after the project. The beneficiaries were individually interviewed and personal observations were also made. The data collected were coded, tabulated, analysed and presented in table to make findings meaningful and easily understandable. The findings emerged out of the data were suitably interpreted and necessary conclusions and inferences were drawn.

RESULTS AND DISCUSSIONS

It is observed from the Table 1, that the mean scores of family expenditure as a whole with its sub items, indebtedness, increase in crop yields, returns on crops and increase in land value were statistically significant at 1 per cent level of probability.

It is observed from the Table 1 that the mean scores of the family expenditure with its sub components like food, clothing, medicines, education, electricity, foot ware, recreation, fuel etc.; indebtedness, increase in crop yields; returns on crops and increase in land value were statistically significant showing that there was a significant difference between family expenditure followed by indebtedness, increasing in crop yields, returns on crops and increase in land value before and after the execution of Operational Research Projects.

The pattern of family expenditure in the items of food, clothing, medicines, education, electricity, foot ware, recreation and fuel has increased substantially after the introduction of Operational Research Project. The Operational Research Project would have helped the farmers to increase their crop production resulting in improved income.

It is quite possible that whenever the income of the farmer increases, the unfelt needs of farmers would have translated into felt needs which need to be satisfied and they think of satisfying them. This would have motivated them to improve the quality of living. Similar findings were also observed by Datta *et al.*, (2000), and Rajvir Singh *et al.*, (2000).

It is in contrast to the popular belief that whenever the farmer increases his income, he will soon clear debts and become less burdened with debts. The finding of the study is just opposite of what we believe and think. This could be due to the fact, that the farmers might be anticipating more income in the years to come as they have experienced the increased income at present and developed the confidence that it is possible. Some of the farmeres with a hope of getting more income in future, purchased agricultural equipment, tractors, land, sent children for residential education and constructed new house. This would have resulted in a significant increase in indebtedness.

The significant difference in average yields upto 1867 kg/ha would have been possible because of their scientific orientation and management orientation etc. It is worthwhile to point out either increase or decrease in yields well depends on its management orientation in general and scientific orientation in particular. Hence, it is evident that the farmers could obtain significant yield increase by managing the crop on scientific lines. Similar results were indicated by Rana *et al.*, (2000), ANGRAU (2002) and Srikanth *et al.*, (2002).

It could be inferred from the findings that the farmers could increase their income on crops after the Operational Research Project started its activities. Though, the returns from crops is the function of number aspects like marketing of the produce, price fixed by the Government, surplus and demand situation etc. It has been a farmer's thinking that the Operational Research Project has helped them to get higher returns.

The similar trend was noticed and were coformity with the findings of Joshi (1994), Datta *et al.*, (2000) and Rajveersingh *et al.*, (2000).

The average increased land value substantially from Rs. 67,147/- to 1,67,882/- per hectare showing the increase of Rs. 1, 04, 735/- per hactare, might be due to the fact the productivity of land as well as returns on crops increased as a result of Operational Research Project leading to increased purchasing power on the part of the farmer. Because of the productivity of land increased, the farmers might have thought that the land would give more productivity of land increased, the farmers might have thought that the land would give more production in future. This would have prompted them to go for the possession of land, which would have created a demand for land and hence the consequences would be increased land value. It is quite natural to think that the productive lands were at increase in value. This finding draws support from the findings of Datta *et al.*, (2000) and ANGRAU (2002).

The corpping pattern i.e., paddy-fallow, was in vogue in Operational Research Project site before implementation of the project, as the land was under registered ayacut of Nagrjuna Sagar Project Right Canal Command and Krishna Western Delta Canal Command, low-lying and with high groundwater table. After project, as the salinity problem was elucidated, the then existing cropping pattern of paddy-fallow was shifted to paddy-pulses in about 60 per cent of Operational Research Project site. The shift in cropping pattern, as such is a visible change. Besides, the positive attitude expressed by the other

farmers to have such change in their holdings in the very next year, is to necessarily be considered as a symbol of success of the project. The finding was endorsed by Mathur *et al.*, (2000) and Datta *et al.*, (2000).

Intensive use of land is an indication of developed confidence of beneficiary, on the land productivity. The cropping intensity in the Operational Research Project site was only 92.50 per cent before project implementation, but was recorded to be increased to the tune of 160 per cent with a recognizable difference of 67.50 per cent. It was possible, as the farmers could, not only take up paddy cultivation successfully on time in entire area unlike yester years but the rice fallow pulse crop also in about 60 per cent of area. The reduced salinity problem facilitated rice fallow pulse crop to get established and the targeted crop intensification programme found fruitful, creating enthusiasm among the farmers to veture in similar direction. This fiding draws support from the findings of Rajvirsingh *et al.*, (2000), Sewaram *et al.*, (2000) and Srikanth *et al.*, (2002).

The employment genration measured in terms of man working days (MWD) was increased after project implementation to the tune of 50 MWD per ha; which is an achievement interms of project success. Further the employment generation projection due to effective implementation of Indo-Duch Network Operational Research Project will be quite encouraging. As the figures of hectare are calculated for the total Operational Research Project area (2381MWD), it would be a land mark achievment in socio-economic milieu. The finding was endorsed by Datta *et al.*, (2000).

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Strategic Management for Cotton Improvement

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ABSTRACT

An innovative strategic management tool - SNAC analysis as a programme methodology was applied to arrive at a strategy for cotton improvement along with figurative diagram. The study conducted in Guntur district of Andhra Pradesh revealed that SNAC strategy includes four areas namely problem identification, solutions suggested (technical competency), implementation of proposed solutions and impact analysis. The overall strategy in planning and implementing the package practices of cotton cultivation depends on the analysis of stake holders (ANGRAU), needs (seed rate and sowing), alterables (growing hybrid cotton) and their constraints (expensiveness of plant protection measures). The outcome of strategy include the following :- Solutions to management of field problems, strategy for effective dissemination of transfer of technology, Linkage with different organizations, Crop management in terms of higher yield, higher income, high level of living and farmer's satisfaction.

Key words : Cotton, Improvement

SNAC analysis is a modern management tool to analyse stake holders, needs, alterables and constraints in cotton cultivation. Stake holders are those groups or individuals who were directly or indirectly affected by an organizations pursuit of goals or affected due to cotton cultivation. Needs implies a gap between 'what is' the existing situation and 'what ought to be' the desirable situation and also a gap between situation and objective. Alterables are traits that are shared by some persons or cotton farmers but not shared by all members of society. Constraint referred to the stem of difficulty faced by cotton farmer in adoption of recommended technology. SNAC analysis is applied in cotton cultivation. Cotton production fell to 11.15 and 12.20 million bales respectively in the years of 1997-98 and 1998-99 from the highest 14.25 million bales recorded in the year of 1996-97. At this high time, there is need for application of SNAC analysis for improvement in cotton cultivation by analyzing stake holders, needs, alterables and constraints which inturn help the top administrators, planners of state government,

scientists of cotton cultivation and cotton farmers for developing a strategy to overcome the constraints in cotton cultivation. Keeping in view, the objective was formulated to develop a strategy and to illustrate figuratively the various analytical components of SNAC analysis in cotton cultivation as a mechanism for the transfer of agricultural technology.

METHODOLOGY

Exploratory research design was followed. Two mandals in Guntur district of Andhra Pradesh were selected purposively for drawing the 110 sample farmers of the study. From each mandal 3 villages were selected randomly. The data were collected by personal interview with the help of structured interview schedule.

RESULTS AND DISCUSSION

The findings resulted in a meaningful strategy for cotton improvement, which includes four areas namely problem identification, solutions suggested, implementation of proposed solutions and impact analysis.

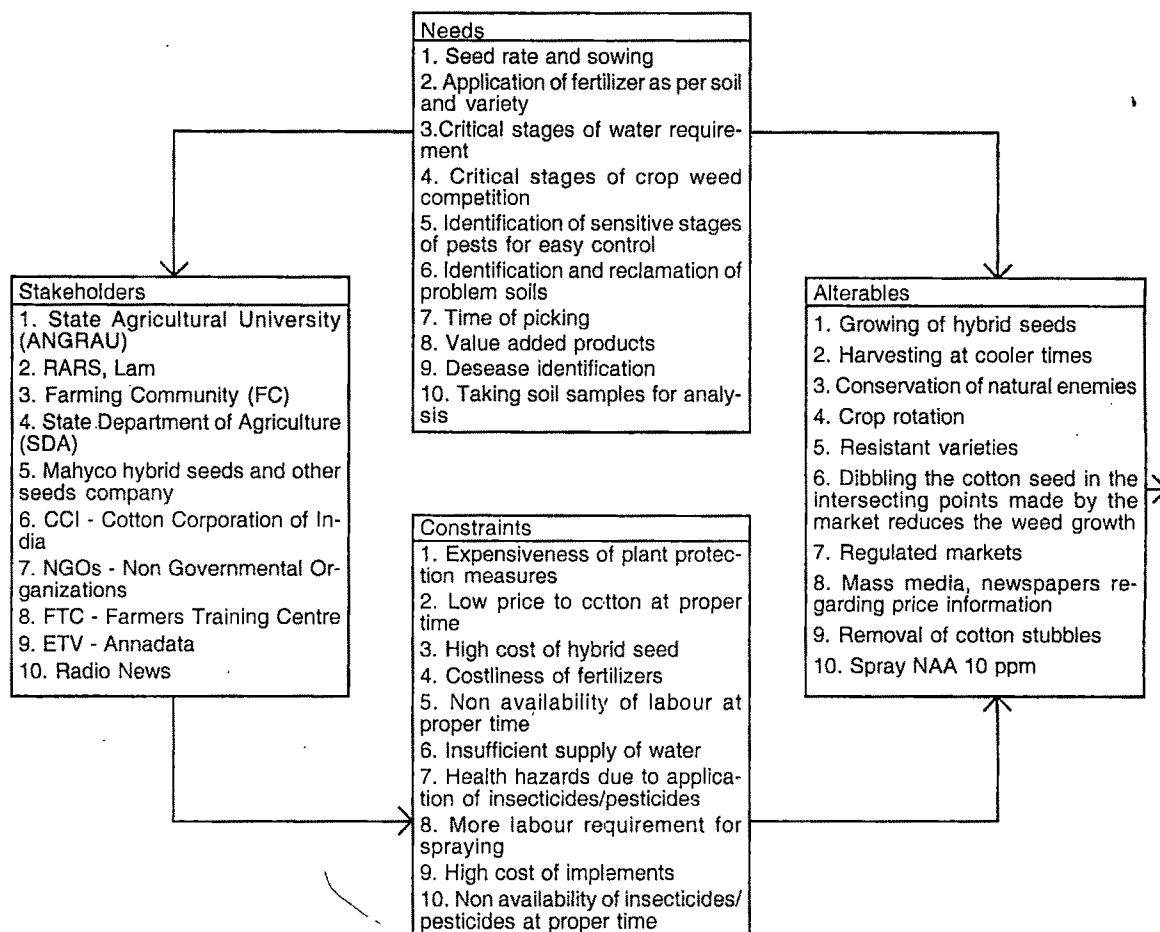


Fig. 1 Figurative diagram of SNAC analysis in detail

I. Problem Identification

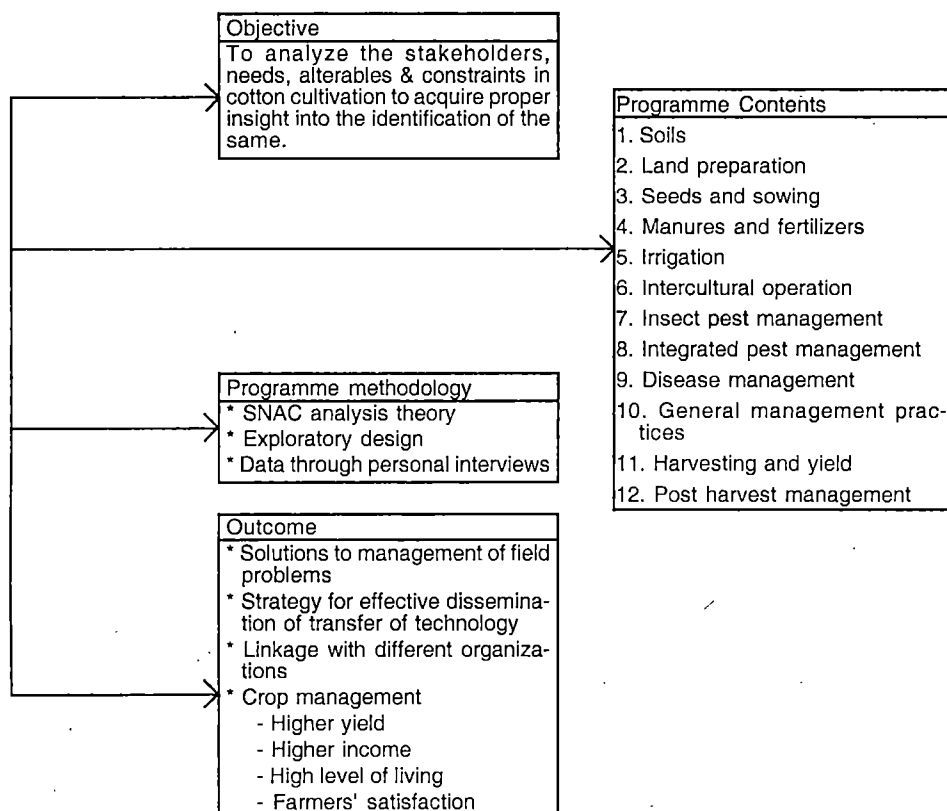
The first and foremost task could be to analyze how accurate and appropriate the problem identification is in cultivation of cotton crop. This would include looking at the aspect such as who identified the problem(s)? Who prioritized these problems? On what criteria the problems have been prioritized? Was the prioritization shared with the client group?

While answering for the above said

questions the cotton farmers have enlisted the problems. Some of the selected problems identified in cultivation of cotton crop were prioritized in consultation with the farmers as follows.

Problems identified in cotton cultivation

1. Expensiveness of plant protection measures.
2. Low price to cotton at proper time.
3. High cost of hybrid seed.



II. Solutions suggested (Technical Competency)

1. The agricultural department should provide subsidy on fertilizers, pesticides, plant protection equipment etc.
2. Government should fix minimum support price by taking into account the realistic cost of cotton cultivation.
3. The state department of agriculture, private agencies should be alerted in supplying good quality of hybrid cotton seed.

III. Implementation of proposed solutions

This would focus on efficiency of

implementation of the solutions that were proposed.

1. Evolving of resistant varieties to pests, diseases, cyclones and droughts because the farmers were getting heavy losses due to the vagaries of monsoon and pests & diseases.

2. The government can extend more technical as well as financial support to cotton cultivation, since it has vast potentiality to earn foreign exchange.

3. Both state as well as central government should take appropriate policies for the development of regulated market structure to get remunerative price for the produce.

IV. Impact analysis

The impact analysis was done in terms of desired aspect as for the initial stated objectives obtained at village level from cotton farmers with all validation of an assumption made while suggesting solutions. Additional benefits/negative impacts were also pruned from the constraints or problems identified for attending to each activity were also included. Of course, the biggest stumbling block faced by the researcher was certain problems expressed and solutions suggested were unclear, vague and non-inconclusive. The impact analysis revealed that the cotton farmers are required to manipulate the non-cash inputs like correct sowing, season, optimum plant population, choosing of quality inputs like seeds, fertilizers and pesticides. Further, they need to draw attention on slow moving technologies like plant protection measures than fast moving technologies like seed/variety adoption, etc.

The SNAC analysis applied in toto certainly showed the great impact on cotton cultivation in terms of higher yields leading to higher income, increase in standard of living thereby cotton farmers satisfaction after passing through the stages of learning process like Attention, Interest, Desire, Conviction, Action and finally Satisfaction.

Thus, the cotton cultivation strategy need to be redesigned in accordance with SNAC analysis to meet the changes or the aspects due to change in the field situation or needs of stake holders.

Stake Holders Analysis

The cotton cultivation has multiple stake holders. These include

1. State Agricultural University (ANGRAU).
2. Regional Agricultural Research Station (RARS), Lam, Guntur.

3. Farming Community.
4. State Department of Agriculture (SDOA).
5. Mahyco Hybrid Seeds and other Seed Companies.
6. Cotton Corporation of India - CCI, Guntur.
7. Non-Governmental Organizations (NGOs).
8. Farmer's Training Centres (FTCs).
9. ETV - Annadata.
10. Radio News.

Needs

The needs of cotton farmers were

1. Seed rate and sowing.
2. Application of fertilizers as per soil and variety.
3. Critical stages of water requirement.
4. Critical stages of crop weed competition.
5. Identification of sensitive stages of pests for easy control.
6. Identification and reclamation of problem soils.
7. Time of picking
8. Value added products.
9. Identification of diseases.
10. Taking soil samples for analysis.

Constraint Analysis

Constraints faced by farmers in cotton cultivation were

1. Expensiveness of plant protection measures.
2. Low price to cotton at proper time.
3. High cost of hybrid seed.
4. Costliness of fertilizers.

5. Non-availability of labour at proper time.
6. Insufficient supply of water.
7. Health hazards due to application of insecticides/pesticides.
8. More labour requirement for spraying.
9. High cost of implements.
10. Non-availability of insecticides/pesticides at proper time.

Alterable Analysis

1. Growing of hybrid seeds for high export potential, high staple length, high fibre strength and high fibre maturity.
2. Picking of kapas free from debris, dried leaves, bracts during cooler times of the day.
3. Conservation of natural enemies.
4. Crop rotation with chillies, jowar, maize, soybean, pulses, sesamum and redgram.
5. Growing of resistant varieties like LPS 161, LS 861, and application of triazophos/ endosulfan/profenophos/ neem oil/ethion for control of white fly.
6. By dibbling the cotton seed in the intersecting points made by the marker reduces the weed growth as it facilitates inter cultivation by working gorru and guntaka on

all directions thereby saving labour on weed management.

7. The regulated markets should provide requisite facilities to farmers for storage, loans, insurance against fire and theft etc., for selling their produce at competitive prices.
8. Good quality of market information regarding prices, etc., should be made available to farmers through mass media, newspapers.
9. Removal of cotton stubbles after last picking without opting for ratoon crop.
10. Spraying of NAA 10ppm for control of bud and boll shedding.

Conclusion

The overall strategy in planning and implementing the package practices of cotton cultivation depends on the analysis of stakeholders, their needs and constraints. It is inferred that the cotton cultivation should strive constantly to be flexible and alterable in shaping the overall strategic management by tackling the field problems for efficient dissemination of transfer of agricultural technology.

A Comparative Study of Knowledge Level of Trained Farmers in Krishi Vigyan Kendra (KVK) of Governmental Organisation and Non-Governmental Organisation in Kurnool District of Andhra Pradesh

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ABSTRACT

The study revealed that majority of trained farmers had high level of Knowledge in case of Governmental Organisation-Krishi Vigyan Kendra (GO-KVK), compared to Non-Governmental Organisation-Krishi Vigyan Kendra (NGO-KVK). 'Z' test statistically proved that GO-KVK was better regarding the knowledge level of trained farmers.

Key Words : Trained Farmers, Krishi Vigyan Kendras

The Indian Council of Agricultural Research has established 261 KVKs by the end of 1995-96 in India with 16 KVKs in Andhra Pradesh (AP) catering to the farming needs of rural community of a district in which it is located. The main theme of these kendra is to provide skill-oriented vocational training to the practicing farmers, rural youth, farm women and to organize training for extension fuctionaries on emerging advances in agricultural research, conduct of on-farm research trials for technology assessment and refinement and to organize frontline demonstrations to educate the farmers on latest agricultural technologies.

METHODOLOGY

Ex-post-facto research design was followed in the present study, Kurnool and Nandyal Revenue Division in Kurnool District of AP was selected purposively on the ground that both Mahanandi (GO-KVK) and Yagantipalle (NGO-KVK) are Located. Two Mandals viz., Mahanandi and Rudravaram from GO-KVK and

two mandals viz., Banganapalli and Koilakuntla from NGO-KVK were selected purposively, because the major crops of Kurnool district like Cotton, Hybrid Jowar and Rice were being cultivated in higher proportion per unit area. Four villages from each of them two KVK were selected purposively as more number of training programmes were conducted in these villages. Thus a total of four mandals and eight villages were selected purposively.

60 trained farmers in each KVK were selected by proportionate random sampling method amounting to a total of 120 trained farmers as respondents. The total number of knowledge items were 52. A score of 'one' was assigned for possessing correct knowledge and 'zero' score for incorrect knowledge on each item by the respondents on production technology of Cotton, Hybrid Jowar and Rice crops and thus knowledge score of each respondent was obtained. The respondents were grouped into three categories viz., Low, Medium and High,

Table 1 : Distribution of Respondents According to their Knowledge Levels in KVKs of GO and NGO.

S.No.	Level of Knowledge	n=60		n=60	
		GO-KVK		NGO-KVK	
		Frequency	Percentage	Frequency	Percentage
1.	Low	10	16.67	7	11.67
2.	Medium	17	28.33	44	73.33
3.	High	33	55.00	9	15.00
	Total	60	100	60	100
		Mean : 39.98		Mean : 38.66	
		SD : 2.91		SD : 4.02	

based on the knowledge scores obtained by adopting mean and standard deviation. The data were collected by personal interview through structured interview schedule for trained farmers. Appropriate statistical procedures like mean, standard deviation, frequency, percentage and 'Z' test were employed to analyse and interpret the data.

RESULTS AND DISCUSSION

It was found from Table 1 and Fig.1 that 55.00 per cent of respondents had high level of knowledge followed by medium (28.33%) and low (16.67%) levels in case of GO-KVK, where as, 73.33 per cent had medium level of knowledge followed by high (28.33%) and low (11.67%) levels in NGO-KVK.

Hence, from the above results, it could be concluded that majority of respondents had high level of knowledge in case of GO-KVK, where as, it was medium level in NGO-KVK.

The probable reason for this trend in GO-KVK might be due to the fact that majority of

respondents had high levels of extension contact and mass media exposure which might have enabled them to be in constant touch with the extension personnel and ANGRAU scientists for seeking advice and clarifying doubts on the topics they had heard through different sources. The possible reason to have medium level of knowledge of respondents in NGO-KVK might be due to the fact that lack of involvement of ANGRAU scientists, language used in the training programmes probably not up to the farmer's level.

The results of high level of knowledge is in line with the results of Kumar(1996) and Hussain(1997), while, medium level is in conformity with Rao(1988), Ananthachary(1990) and Veeraiah *et al.*, (1998).

An attempt was also made to find out the significance of the apparent differences in the mean knowledge scores of respondents in KVKs of GO and NGO with the help of 'Z' test. The size of the sample, mean and standard deviation of the two organisations were presented in Table 2.

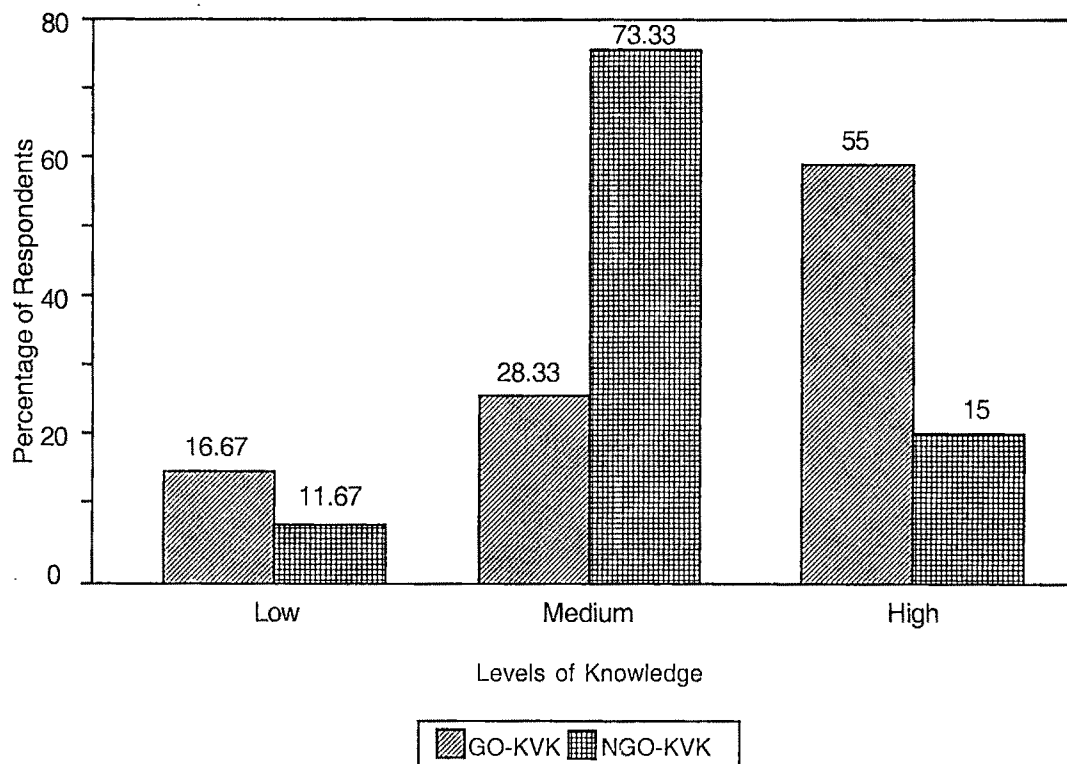


Fig. 1 Distribution of Respondents According to their Levels of Knowledge

Table 2 : Difference in the Knowledge Level of Respondents in KVKs of GO and NGO

S.No.	Organisation	Size of Sample	Mean	SD	'Z' Value
1.	GO-KVK	60	39.98	2.91	
2.	NGO-KVK	60	38.66	4.02	2.062*

It was evident from Table 2 that the calculated 'Z' value (2.062) was greater than the table 'Z' value at 0.05 level of probability. So, it could be concluded that there exists a significant difference between mean knowledge scores of respondents in KVKs of GO and NGO. Hence, it was statistically proved that GO-KVK was found superior with respect to knowledge level of respondents compared to NGO-KVK.

The high level trend of knowledge of respondents of GO-KVK need to be maintained in the same manner, where as, it is desirable to develop knowledge of respondents in NGO-KVK to high level through more involvement of extension personal and ANGRAU scientists and by providing the agricultural information materials on the topics covered in the training programmes.

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A Comparative Study on The Problems in Utilisation and Suggestions for Effective Utilisation in Watershed Development Programmes of Governmental Organisation and Non-Governmental Organisation

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ABSTRACT

The data was collected from 120 beneficiaries of watershed development programme's (WSDP's) of governmental organisation (GO) and Non-governmental organisation (NGO). High cost of recommended technologies was the major problem and low cost technologies are to be developed and advocated as suggested by the beneficiaries of both GO and NGO for effective utilisation of recommended technologies in WSDP.

Key Words : Watershed Development, Governmental, non-Governmental.

The study mainly contemplates to find out comparatively the problems in utilisation of recommended technologies and suggestions given by the beneficiaries for effective utilisation of recommended technologies in WSDP's of GO and NGO. The findings of the study could help the personnel involved in WSDP to take appropriate measures to disseminate and to utilise recommended technologies in different components of WSDP. The study will have an additional advantage that good points of the organisations can be exchanged and discrepancies in both organisations can be identified and rectified. The comparative study of problems and suggestions in utilisation of recommended technologies in WSDP's of GO and NGO will provide an opportunity to identify the root causes of hinderances that impede the efficiency and effectiveness of the programme. Keeping such in view the present study conducted to find out comparatively the problems

in utilisation and suggestions for effective utilisation of recommended technologies in different components of WSDP.

METHODOLOGY

The beneficiaries have asked to state the problems in utilisation and suggestions for effective utilisation of recommended technologies in different components of WSDP. The problem and suggestion that was mentioned by maximum number of beneficiaries would become the first problem and first suggestion respectively in different activities of WSDP and the rest follow in order of magnitude as 2nd, 3rd, 4th and so on.

RESULTS AND DISCUSSION

It was evident from Table 1 that high cost of recommended technologies (81.66%), lack of timely supply of inputs and implements (70.00%), lack of timely technical guidance (33%), lack of

Table 1 : Problems of beneficiaries in utilisation of recommended technologies in WSDP's of GO and NGO
n = 60
n = 60

S.No.	Problems	GO			NGO		
		Frequency	%	Rank	Frequency	%	Rank
1.	High cost of recommended technologies	49	81.66	I	47	78.33	I
2.	Lack of timely supply of inputs and implements	42	70.00	II	11	18.33	VIII
3.	Lack of timely technical guidance	33	55.00	III	8	13.33	IX
4.	Lack of organisation of result and method demonstration in sufficient number	28	46.66	IV	13	21.66	VII
5.	Lack of adequate skills to utilise recommended technologies	22	36.66	V	18	30.00	VI
6.	Non-availability of credit in time	17	28.33	VI	21	35.00	V
7.	Unforeseen disease and pest attack	13	21.66	VII	43	71.66	II
8.	Failure of crops due to delay/no rains	9	15.00	VIII	32	53.33	III
9.	Lack of co-operation among neighbouring beneficiaries	7	11.66	IX	26	43.33	IV

organisation of result and method demonstrations in sufficient number (28%), lack of adequate skills to utilise recommended technologies (22%) in GO whereas high cost of recommended technologies (78.33%), unforeseen disease and pest attack (71.66%), failure of crops due to delay / no rains (53.33%), lack of cooperation among neighbouring beneficiaries (43.33%), non availability of credit in time (35%) in NGO were the major problems. The non availability of credit in time (28.33%), unforeseen disease and pest attack (21.66%), failure of crops due to delay/no

rains(15.00%), lack of cooperation among neighbouring beneficiaries(11.66%) in GO whereas lack of adequate skills to utilise recommended technologies (30.00%), lack of organisation of result and method demonstrations in sufficient number (21.66%), lack of timely supply of inputs and implements (18.33%), lack of timely technical guidance (13.33%) in NGO were the other problems metioned by the beneficiaries of WSDP.

This indicates that the beneficiaries of GO and NGO are plagued by high cost of

Table 2 : Suggestions of the beneficiaries for effective utilisation of recommended technologies in WSDP's of GO and NGO

S.No.	Suggestions	GO			NGO		
		Frequency	%	Rank	Frequency	%	Rank
1.	Low cost technologies to be developed and advocated	46	76.66	I	45	75.00	I
2.	Timely supply of inputs and implements is essential	41	68.33	II	9	15.00	VIII
3.	Timely technical guidance is to be given	31	51.66	III	7	11.66	IX
4.	Sufficient number of result and method demonstrations to be conducted	26	43.33	IV	11	18.33	VII
5.	Adequate pre and post seasonal trainings to be conducted	21	35.00	V	17	28.33	VI
6.	Providing timely credit at lower rates of interest	15	25.00	VI	19	31.66	V
7.	Educating the beneficiaries on IPM	12	20.00	VII	41	68.33	II
8.	Cropping systems to be planned according to climatic fluctuations and supply of drought resistant varieties	8	13.33	VIII	29	48.33	III
9.	Setting conflicts among neighbouring beneficiaries through negotiations	7	11.66	IX	24	40.00	IV

recommended technologies. The beneficiaries in GO had suffered from lack of timely supply of inputs and implements (70.00%), lack of timely technical guidance (55.00%), few results and method demonstrations (46.66%), lack of skills to utilise recommended technologies (36.66%) whereas the beneficiaries in NGO had suffered from disease and pest attack, climatic

fluctuations, lack of cooperation among fellow beneficiaries and non-availability of credit in time at lower rate of interest.

It was evident from Table 2 that low cost technologies have to be developed and advocated (76.60%), timely supply of inputs and implements (68.33%), providing timely technical guidance (51.66%), conducting sufficient number

of result and method demonstration (43.33%), conducting adequate pre and post seasonal trainings (35%) in GO, whereas low cost technologies to be developed and advocated (75%), educating the beneficiaries on IPM (68.33%), planning cropping system according to necessity (48.33%), negotiations for settling conflicts (40%), providing timely credit at lower rates of interest (31.66%) in NGO were the major suggestions given by the beneficiaries. Providing timely credit at lower rates of interest (25%), educating the beneficiaries on IPM (20%), planning cropping systems according to necessity (13.33%), settling conflicts through negotiations (11.66%) in GO where as adequate

pre and post seasonal trainings to be conducted (28.33%), sufficient number of result and method demonstrations to be conducted (18.33%), timely supply of inputs and implements is essential (15%), timely technical guidance is to be given (11.66%), in case of NGO were the other suggestions given by the beneficiaries for effective utilisation of recommended technologies in WSDP.

Hence, it is advised that the concerned authorities must take proper steps to implement the suggestions given by beneficiaries of GO and NGO for effective utilisation of recommended technologies in WSDP.

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An Impact Study on Frontline Demonstrations in Oilseeds and Pulses in Warangal District of A.P.

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ABSTRACT

The impact study indicated that yields in both the oilseed and pulse crops under frontline demonstrations were higher and superior in demonstration plots compared to the local ones (farmer's practice) and this is due to use of improved varieties and adopting the recommended scientific package. The percentage increase in yield varied from 45 to 97 per cent in pulses and 26 to 60 per cent in oilseeds. Having gained the technical, technological and material benefits in time, farmers gave positive feed back and appreciated the efforts of scientists. Further, it was also found that seed given under these demonstrations is multiplied and is under vast area in the district.

Key words : Frontline, Oilseeds, Pulses.

Krishi Vigyan Kendra's (KVKs) were established as innovative institutions for imparting need based and skill oriented vocational training to practising farmers, in service field level extension functionaries, rural youth and school dropouts in agriculture, poultry, sericulture, fisheries, home science and other allied fields. Besides training, it is mandatory to organise frontline demonstrations (FLDs) and On-farm trials in oilseeds, pulses and other important crops of the district in both *Kharif* and *rabi* seasons for assessment, refinement and effective transfer of technology to the farming community.

Frontline demonstration is one of the important activity of the KVKs and it is organised every year for testing and verifying the latest agricultural technologies in the farmers conditions and identifying the production constraints. The demonstrations are conducted in selected locations of different villages with the willing farmers to experience the latest

technology which include some of the need-based critical inputs like seed, fertiliser, pesticides, fungicide etc. The demonstrations are laid out in the farmer's field by the farmer himself under the supervision of the scientists of the kendra.

The Krishi Vigyan Kendra located in Warangal district in A.P. has been implementing FLDs since its inception and during the past five years it had organised 261 such demonstrations in an area of about 106 hectares in 30 villages of the district in oilseeds and pulses. It rendered a commendable service in the form of giving strong training support in achieving a break through in agricultural production in the district.

As these demonstrations are organised every year, it was felt necessary to know the impact of FLD's organised by the KVK in terms of its performance, yields and farmers feedback and the study was planned with the following objectives:

Table 1 : Details about Crops Acreage/No. of Demonstrations laid under FLD

Crop	1995-96		1996-97		1997-98		1998-99		1999-2000	
	No.	A	No.	A	No.	A	No.	A	No.	A
Greengram	13	5.0	6	2.0	1	4.0	6	2.0	10	4.0
Red gram	-	-	-	-	8	3.2	10	4.0	10	4.0
Blackgram	12	4.0	7	4.0	10	4.0	10	4.0	11	4.0
Sesamum	12	4.8	-	-	-	-	-	-	-	-
Sunflower	19	8.0	13	4.0	10	4.0	13	5.0	13	5.0
Groundnut	11	5.0	20	8.0	11	4.0	13	5.0	12	5.0

No. = No. of demonstrations

A = Area in hectares

1. To find out the impact of FLD's in terms of performance at farmers level during last five years and

2. To know the feedback from beneficiary farmers about these demonstrations.

MATERIAL AND METHODS

An ex-post-facto study was conducted to know the impact of FLD's organised by the KVK in the district. All the 30 villages of the district where these demonstrations were organised and all 282 participant farmers who had implemented the programme were selected purposively. Care was taken to see that these FLD's were organised with only those farmers who had experience of growing the field crops for more than five years and majority of the respondents in the study belonged to scheduled tribe category. Data was collected personally by structured interview schedule and analysed using simple frequencies and percentage.

RESULTS AND DISCUSSION

The demonstrating farmers in FLD's were requested to implement the programme in pulses and oilseeds crops. In pulses, Greengram-the varieties were MGG-295, WGG-2 and in

Blackgram - LBG-17, LBG-20, LBG-611 and in Redgram - WGG-2. Similarly, in oilseeds in Sesamum the variety was Rajeshwari, and in Sunflower - APSH-11, MSFH-8 and in Groundnut - JL-24 and K-134. The above improved varieties and hybrids are found suitable and recommended for the district. The identified farmers were given the seed of above listed varieties as one of the important critical input besides other inputs like fungicides and plant protection chemicals on need basis for implementing the programme.

During the years 1995-96 to 1999-2000 (5 years) in the oilseeds, the programme was implemented in 57.8 ha. with 147 farmers and similarly in pulses in 48.2 ha. with 135 farmers of the district. The details about number of demonstrations and the acreage under different crops both in oilseeds and pulses is given in Table-1. The area under oilseeds in Groundnut 27 ha., Sesamum 4.8 ha and Sunflower 26 ha. Similarly, under pulses the area was in Greengram 17 ha. Blackgram 20 ha. and Redgram 11.2 ha.

It is evident from the Table-2 that the yields under demonstrations were higher compared to farmers practise and that was

Table 2 : Performance of FLDs under Various Pulses and Oilseed Crops

Crop/ Variety	1995-96			1996-97			1997-98			1998-99			1999-2000			Average yield increase over local%
	D	LC	%	D	LC	%	D	LC	%	D	LC	%	D	LC	%	
Pulses																
Greengarm																
MGG-29	8.5	4.37	94.5	9.8	6.5	50.76	10.75	6.8	58.08	-	-	-	-	-	-	84
WGG-2	-	-	-	-	-	-	-	-	-	11.0	4.75	131.57	10.85	5.5	97.27	
Redgram																
MRG-66	-	-	-	-	-	-	18.35	12.15	51.22	18.34	12.25	51.12	12.35	8.34	46.85	44
Blackgram																
LBG-17	10.2	5.5	85.45	-	-	-	-	-	-	-	-	-	-	-	-	
LBG-20	-	-	-	9.6	6.8	41.17	-	-	-	-	-	-	-	-	-	70
LBG-611	-	-	-	-	-	-	9.15	4.5	103.33	8.25	5.5	49.99	-	-	-	
Oilseeds																
Sesamum																
Gauri	12.35	8.75	41.14	-	-	-	-	-	-	-	-	-	-	-	-	41
Sunflower																
APSH-11	-	-	-	13.45	9.13	47.31	-	-	-	-	-	-	-	-	-	50
MSFH-8	15.4	9.86	56.18	14.5	9.5	52.63	12.53	9.93	26.0	17.12	10.68	60.20	13.45	8.80	52.84	
Groundnut																
JL-24	22.64	16.05	41.0	22.4	15.0	49.0	-	-	-	-	-	-	-	-	-	25
K-134	-	-	-	23.5	16.0	47.0	21.5	17.0	26.4	15.18	12.65	19.99	17.0	13.1	29.7	
D = Demonstration Plot Yield (q/ha) LC = Local Check Yield (q/ha) % = Percent increase over local check																

D = Demonstration Plot Yield (q/ha) LC = Local Check Yield (q/ha) % = Percent increase over local check

mainly due to the use of improved and latest varieties of seed both oilseed and pulses given to farmers. The supplied seed had higher yield potentiality with resistance or tolerance to local pests and diseases. The seed was purchased from various Agricultural Research Stations of the University. Beside good quality seed, the selected farmers were given other inputs like fungicides, plant protection chemicals as per the need. The farmers were also given thorough orientation about scientific package of the crop which includes some of the important aspects like seed treatment, judicious use of fertilisers involving integrated nutrient management, application, water management, need based plant protection measures including Integrated Pest Management, harvesting etc.

The improved green gram varieties MGG-295 and WGG-2 are found to be highly promising and had given fairly good yields (86 per cent higher) over local ones and this is probably due to the fact that in the villages farmers do not apply fertilizers to the pulse crop and think it is only a minor crop or bonus crop and mostly they use local varieties which are poor performers which they call as 'Chamkilu' in their local language. MGG-295 was found to be tolerant to angular black leaf spot disease. Similarly, the MRG-66 red gram has yielded more than the local one (44 per cent) and this is due to use of wilt resistant variety (as wilt is a problem in the district and yields are drastically poor due to this disease) and timely plant protection measures advised to the farmers. They refer local variety as 'banda kandulu' or 'erra or chinna kandulu'. It is seen from the Table-2 that yields of the black gram with varieties LBG-17, LBG-20 and LBG-611 were found to be superior than local check (70 per cent) and this is probably

due to use of improved varieties and management aspects like fertilizers application and timely plant protection measures. The farmers call the local black gram as 'butta minumulu' however, T-9 is also one of the oldest variety used by the farmers locally.

In the oilseed crops in sesamum the Rajeshwari variety has out yielded the local one by 41 per cent as this white seeded variety having high yield potential suitable for all seasons particularly summer. The higher yield is probably due to the use of this variety coupled with timely plant protection measures. The higher yields (50 per cent more) in sunflower is due to the use of hybrids and method of sowing. In villages, when the crop was new the sunflower seed was sown behind the plough like any other seed and due to this the seed was placed very deep and with a result there was poor germination and plant population stand, and has demonstrated seeding by hand dibbling method. In groundnut crop, use of JL-24 and K-134 varieties have given 25 per cent more yield than the local and this again due to the use of good improved seed, maintaining of plant population, use of gypsum at 35 days of sowing and timely plant protection measures as advised by the scientist of the kendra. By and large the regular monitoring and supervision of FLDs and giving timely advise to farmers by the concerned scientists play a great role in successful implementation of these demonstrations and in the process of close monitoring and regular visits to these demonstrations lot of information is generated from the farming community about the gaps, technical, operational constraints difficulties faced by them and particularly their feed back is very important for refinement of the technology.

Pulses

From the study it was found low yields were recorded in local check and this was due to non-adoption of package of practices like use of local variety, non-application of fertilizers and plant protection chemicals in time. Scientists must conduct pre-season training programmes to farmers and extension functionaries regarding improved production technology in pulses.

Oilseeds

From the investigation it was found that majority of the farmers are using old local seed which is low in yields that are susceptible to pests and diseases and they are not maintaining optimum plant population and thereby yields are

low. Farmers have expressed that seed of high yielding varieties to be given to them. In sesamum there are good varieties like JCS-16, Rajeshwari, Swetha til and JCS-94. Similarly in groundnut varieties are JL-24, TG-26.

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Estimation of Inadequate Scale of Finance for Paddy and Chilli Crops by Lead Bank in Guntur District of Andhra Pradesh

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ABSTRACT

The study revealed that the validity of the loan components and the scale of finance of the crop loan system in the district are not in consonance when compared with the Bulk line cost of cultivation with regard to the major crops viz., Paddy and Chilli. The study shows the cost of cultivation data being used for the fixation of scale of finance by DCC was no more vogue. The crop loans being advanced by Lead bank, covered only to the extent of 65.39% and 59.72% of the total Bulk-Line cost of cultivation of paddy and chillies respectively. It also revealed that inadequacy of scale of finance is more in commercial crops.

Key words : Inadequate, Finance, Paddy, Chilli

Credit is said to be a live blood of agriculture and is a device for the temporary transfer of purchasing power from one individual to another. Credit is an important instrument that can effectively be used for adoption/spread of an economic activity at individual levels. It is true for the rural sector of developing economics, which are considered as capital starved but have the potential to grow. Agricultural credit is considered as one of the most basic input for conducting all agricultural development programmes. In India there is an immense need for proper agricultural credit as Indian farmers are poor. From the very beginning the prime source of agricultural credit in India was moneylenders. After Independence the government adopted the Institutional credit approach through various agencies like Co-operative Commercial banks, Regional Rural banks; etc., to provide adequate credit to farmers, at a cheaper rate of interest. Moreover, with growing modernization of agriculture during post green revolution Period

the requirement of agricultural credit has increased further in recent years. This study is an attempt in this direction to assess the adequacy of credit by Lead bank in Guntur district of Andhra Pradesh.

METHODOLOGY

A three stage sampling technique was adopted to select the mandals, villages, and ultimately the farmers. In the first stage the 57 mandals under the finance were arranged in ascending order and then the top three mandals were selected for the study. During the second stage all the villages under finance in each mandal are arranged in ascending order and then the top two villages were selected. In the last stage that is the third stage a sample of 15 farmers were selected from each village for the study. Thus a total of 90 farmers were selected from three mandals as a sample for the study. The main crops in the study area are paddy and chillies, so the borrowers under these two main

Table 1 : Bulk-line cost for Paddy and Chilli

Si. No	Range of cost cultivation		Cumulative Percentage			
	Rs/ha		Output	Farmers		Area
1.	Below	18000	Paddy 12.5	13.3		6.15
2.	18000	-19000	34.5	36.6		18.2
3.	19000	-20000	43.1	45.4		25.75
4.	20000	-21000	68.4	70.9		53.03
5.	21000	-22000	91.2	92.0		87.67
6.	Above	22000	100	100		100

Si. No	Range of cost cultivation		Cumulative Percentage		
	Rs/ha		Output	Farmers	Area
1.	Below	46000	Chilli 14.68	15.55	6.82
2.	46000	47000	35.04	36.66	17.97
3.	47000	48000	47.72	48.89	30.12
4.	48000	49000	68.48	68.89	50.18
5.	49000	50000	86.59	87.77	89.32
6.	Above	50000	100	100	100

crops were taken as the base for the study. Bulk-line cost of cultivation has been worked out for two crops viz., paddy and chillies. Bulk-line cost of production is that cost which covers cost of production of majority of farmers, or production or area.

Conventionally the bulk line cost is calculated so as to cover 85% of the farmers or production or area on the cost 'C' basis.

RESULTS AND DISCUSSION

The Bulk-line cost was worked out in rupees per hectare and recommended the scale of finance crop-wise, for paddy and chilli.

Bulk-line Cost for Paddy

The details of cumulative percentages of the total output, farmers and area under paddy to the respective totals according to the range of cost of cultivation per hectare were presented in Table-1. The bulk-line cost of cultivation of paddy worked out to be Rs. 21103/- ha covering 85% of output, farmers and area.

Bulk-line cost for Chillies

The details of the cumulative percentages of the total output, farmer and area under chilli to thier respective totals according to the range of cost of cultivation per hectare was presented in Table-2.

Table 2 : Comparison between Bulk-line and Scale of Finance

Sl.No	Crop	Bulk-line cost (Rs/ha)	Total cost C (Rs/ha)	Scale of finance (Rs/ha)	Scale of finance as % to Bulk-line cost	Scale of finance as % to total cost	% Gap between Bulk-line cost & scale of finance
1.	Paddy	21103	24827	13800	65.39	55.58	44.42
2.	Chilli	49225	57912	29400	59.72	50.76	49.24

The bulk-line cost of cultivation of chillies was worked out to be Rs. 49225/-, which covers 85 per cent of output, farmer and area. It is revealed that in case of two crops *i.e.*, paddy and chilli 85 per cent in every respect (output, farmer and area) was covered by Bulk-line cost. Therefore it is scientific to adopt this cost for fixing the scale of finance and observe whether the scale of finance fixed by DCC (District Consultative Committee) would stand for the test of adequacy or not.

Bulk-line cost and scale of finance

The values of the bulk-line costs calculated and scales of finance fixed by DCC for two crops *i.e.*, paddy and chilli were presented in table-3. The details furnished in the table-3 indicate that scale of finance fixed by DCC were much lesser than the total costs. The scale of finance (Rs 13,800) of paddy was 55.58 per cent

of its total cost (Rs. 24,827) while that for chilli was (Rs. 29,400) 50.76 per cent of its total cost (Rs. 57,912). Hence the scale of finance left, an uncovered gap of 44.42 per cent and 49.24 per cent of the total cost in case of paddy and chilli crops respectively. So by utilizing the bulk-line cost the scale of finance has to be fixed by DCC. The perceptible reason for the fixation of such inadequate scales might be due to incorrectness or out datedness of the data considered for the purpose by the DCC. Thus, the study clearly refused the inadequacy of scale of finance for the two crops and more in commercial crops.

Conclusion

The loan amount sanctioned for paddy crop was inadequate (34.61 per cent) as the scale of finance fixed by DCC was inadequate to the working capital needs of the borrowers. So the scale of finance has to be increased to release the farmers from the financial stress.

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Economics of IPM and Non-IPM Technologies on Cotton and Paddy

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ABSTRACT

Realising the damages caused to environment and losses to the farmers due to the indiscriminate and excessive use of pesticides by farmers, an attempt has been made by the scientists to develop an Integrated Pest Management Technology (IPM) at the regional Agricultural Research Station, Lam and Agricultural Research Station, Maruteru, West Godavari district. Experiments were conducted on IPM technology vis-a-vis Non-IPM technology on cotton and paddy crops, respectively. The total cost of cotton cultivation per hectare worked out to Rs. 31,768 and Rs. 33,606 with IPM and Non-IPM technologies, respectively. Net returns of Rs. 7,732 were obtained in case of IPM, as against Rs. 2,394 in case of Non-IPM technology. Similarly in the case of paddy cultivation, the total cost of cultivation for hectare was Rs.15,471 and Rs.16,557 with IPM and Non-IPM technologies. The benefit-cost ratios of IPM and Non-IPM in cotton were 0.24 and 0.07 and 0.69 and 0.46 on IPM and Non-IPM technologies on paddy, respectively. Thus IPM technology is economically viable in view of low cost and high profit margins and practically feasible.

Key Words : I.P.M; Non-I.P.M. Technologies, Cotton, Paddy

In view of the multiple damages due to indiscriminate pesticide usage, several countries, including India have introduced Integrated Pest Management Technologies which are based on natural balancing forces in ecological system.

IPM technology for cotton in Guntur district has been developed by Regional Agricultural Research Station, Lam farm, Guntur and for paddy, it has been proposed by Agricultural Research Station, Maruteru, West Godavari district. Economic viability of the Integrated Pest Management Technology was tested by conducting on-farm trials at Gottipadu village, near Guntur for cotton and in surrounding village of Maruteru, in West Godavari district for paddy.

Costs

The Tables 1 and 2 revealed that the total costs were higher in Non-IPM farms compared to IPM farms in both the crops. The total costs in IPM and Non-IPM farms per hectare was

Rs.15,471 and Rs.16,557, respectively for paddy crop. Similarly, for cotton, the total costs per hectare were Rs.31,768 in IPM farms and Rs.33,605.63 in Non-IPM farms.

The total operational costs which include material costs and labour costs per hectare was Rs.11,107 (71.79%) in IPM farms and Rs.12,503 (75.52%) in Non-IPM farms of Paddy Crop. While in cotton it was Rs.21,893 (68.92%) and Rs.24,605 (73.22%), respectively. More operational costs in Non-IPM farms were mainly due to more expenditure incurred on plant protection chemicals/agents and fertilizers in both the crops. The expenditure on plant protection chemicals/agents per hectare in IPM and Non-IPM farms was Rs.2,950 (9.28%) and Rs.5,900 (17.56%) on cotton crop and Rs.600 (3.87%) and Rs.1,460 (8.82%) on paddy crop, respectively. Similarly, the expenditure on fertilizers in IPM and Non-IPM farms per hectare

Table 1 : Costs and returns of cotton production with IPM and Non-IPM technology (Research Station farms)

S.No.	Particulars	IPM	Non-IPM
I	Operational Costs		
	1. Material costs		
	Seed	625 (1.97)	725 (2.15)
	Manures (FYM)	3,755 (11.82)	2,050 (6.10)
	Plant protection agents/chemicals	2,950 (9.28)	5,900 (17.56)
	Fertilizers	1,500 (4.72)	4,092.50 (12.17)
	Irrigation charges	250 (0.79)	— —
	Total material costs	9,080 (28.58)	12,767.50 (37.99)
	2. Labour Costs	12,150 (38.24)	11,097.50 (33.0)
	Interest on working capital @ 12.5% for half of the crop growth period	663.44 (2.09)	745.63 (2.22)
	Total Operational Costs (1+2)	21,893.44 (68.92)	24,605.63 (73.22)
II	Fixed Costs		
	Rental value of owned land	9,875 (31.08)	9,000 (26.78)
III	Total Costs (I+II)	31,768.44 (100)	33,605.63 (100)
IV	Returns		
	Gross returns-main crop	34,000.00	36,000.00
	Intercrop	5,500.00	—
	Gross returns	39,500.00	36,000.00
	Net returns	7,731.56	2,394.37
	Benefit-cost ratio	0.24	0.07

Note : Figures in parentheses indicate percentage to total.

Table 2 : Costs and returns of paddy cultivation with IPM and Non-IPM technology (Research Station farms)

S.No.	Particulars	IPM	Non-IPM
I	Operational Costs		
	1. Material costs		
	Seed	650 (4.20)	725 (4.38)
	Farm yard manure	3,525 (22.78)	2,120 (12.80)
	Fertilizers	1,020.35 (6.59)	1,736.25 (10.49)
	Plant protection agents/chemicals	600 (3.87)	1,460 (8.82)
	Irrigation charges	500 (3.23)	500 (3.02)
	Sub total	6,295.35 (40.67)	6,541.25 (339.51)
	2. Labour Costs	4,530 (29.28)	5,645 (34.09)
	Interest on working capital @ 12.5%	281.91 (1.82)	317.35 (1.92)
	Total Operational Costs (1+2)	11,107.26 (71.79)	12,503.60 (75.52)
II	Fixed Costs		
	Rental value of owned land	4,364.58 (28.21)	4,053.60 (24.48)
III	Total Costs (I+II)	15,471.84 (100)	16,557.20 (100)
IV	Returns		
	Gross returns	26,187.50	24,321.60
	Net returns	10,715.66	7,764.40
	Benefit-cost ratio	0.69	0.46

Note : Figures in parentheses indicate percentage to total.

was Rs.1,500 (4.72%) and Rs4,092 (12.17%) on cotton and Rs.1,020 (6.59%) and Rs.1,736.25 (Rs.10.49) in paddy, respectively. The lower cost on plant protection and fertilizers in both the crops could be attributed to the fact that in IPM farms, more of farm yard manure (Rs.3,525 was incurred as against Rs.1220 in Non-IPM farms) instead of chemical fertilizers, which would add more fertility to soil and also supplied nutrients to the crop for long period.

Labour costs for operations like preparatory cultivation, plant protection measures, sowing, fertilizer applications, weeding, intercultivation and harvesting were higher in IPM farms compared to Non-IPM farms in cotton crops. It accounted for 38.24 per cent (Rs.12,150) in IPM farms 33.02 per cent (Rs.11,097) in Non-IPM farms. This might be due to adoption of cultural practices like deep summer ploughing, seed treatment, etc., and several mechanical practices for pest control in IPM farms. Besides costs incurred on harvesting and threshing with respect to intercropping was taken up in farms with IPM practices. But, these were absent in farms where IPM technology was not adopted. However, the labour costs were lower in the case of paddy with IPM practices compared to Non-IPM farms due to the reason that costs incurred on weeding and intercultural operations was less as preparatory cultivation was done thoroughly in IPM farms and also spraying was taken up only once, whereas in non-IPM farms sprayings were taken up three times. The labour costs in paddy non-IPM farms per hectare was Rs.5,645 (34.09%) and Rs.4,530 (29.28%) in IPM farms.

With respect to fixed costs, only rental

value of owned land was taken. Land revenue, depreciation, etc., were not taken into account as they were considered as non-cash expenses. The fixed costs per hectare were slightly higher in IPM farms (Rs.4,364.58 for paddy and Rs.9,875 for cotton) compared to non-IPM farms (Rs.4,053 for paddy and Rs.9,000 for cotton) This might be due to more gross returns which reflects on the rental value of owned land in IPM farms than in non-IPM farms in both the crops.

Returns

A perusal of Table 1 and 2 indicated that gross returns and net returns were higher in farms where IPM technology was adopted. The gross and net returns per hectare in farms with IPM technology were Rs.26,187 and Rs.10,715, respectively for paddy crop and Rs.39,500 Rs.7731 for cotton crop respectively while in non IPM farms it was Rs.24,321/- and Rs.7764 on paddy and Rs.36,000 and Rs.2,394 on cotton, respectively. This indicated that there was an additional net income of Rs.5,337 and 2,951 for cotton and paddy crops, per hectare respectively with IPM technology. Thus, it can be concluded that IPM technology was more profitable compared to non-IPM technology or traditional technology.

An analysis benefit-cost ratio showed that the benefit-cost ratios per hectare were 0.69 and 0.46 in paddy IPM and non-IPM farms, respectively and 0.24 and 0.07 in cotton IPM and non-IPM farms, respectively. This indicated the profitability and efficiency of IPM technology. Thus, it was inferred from the above study that the technology is economically viable in view of low costs and high profit margins apart from providing additional employment.

Resource Productivity, Returns to Scale and Resource use Efficiency in Paddy Farms of Ranga Reddy district of Andhra Pradesh.

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ABSTRACT

An attempt is made in this paper to estimate resource productivity and resource use efficiency. Farmers numbering 240 were selected from both watershed (adopters) and non-watershed (non-adopters) areas at the rate of 120 each. The farmers were categorized into small (less than 2 ha), medium (2 to 4 ha) and large (4 ha and above) based on the operational holdings. The data were collected through interview method. Cobb-Douglas production function model was used to estimate the resource productivity and returns to scale on adopter and non-adopter farms. Human labour was found to be dominantly influencing the output in all size-groups on the adopter farms.

Key Words : Productivity, Efficiency, Paddy Farms.

Increasing costs of agricultural inputs by quantum jumps has been making agriculture a loosing proposition. The profitability of crop production has been dwindling in real terms. There exists resource-use inefficiency on the farms. Increasing efficiency of resource-use through appropriate allocation not only increases the productivity but also profitability on the farms. Since, paddy is the most important crop of the state, a study was undertaken with the specific objective of estimating resource productivity and resource-use through appropriate allocation not only increases the productivity but also profitability on the farms. Since, paddy is the most important crop of the state, a study was undertaken with the specific objective of estimating resource productivity and resource-use efficiency.

METHODOLOGY

Six villages in Maheswaram watershed and three villages in non-watershed, but abutting the Maheswaram Watershed in Rangareddy district of Andhra Pradesh were selected for the study. Farmers from the watershed and non-watershed areas were termed as adopters and non-adopters (of technology) respectively. Farmers numbering 240 were selected from both watershed and non-watershed areas at the rate of 120 each. The farmers were categorized into small (less than 2 ha), medium (2 to 4 ha) and large (4 ha and above) based on the operational holdings. The required data were collected through interview method with the help of a pretested schedule. The data pertains to the agricultural year 1988-89.

Table 1 : Production Elasticities and Related Statistics : Paddy (Value in Rupees) Per farm

Sl.No	Particulars	Small	Medium	Adopters Large	Overall	Small	Medium	Non-adopters Large	Overall
1.	No. of fares								
	Constant (log a)	1.8993	-2.9022	1.9716	0.4283	2.9989	2.0884	2.2222	2.8455
2.	Production elasticities								
	Land (ha)	-	-	-	-	-	-	-	-
	Human labour	2.1275\$\$ (1.3672)	1.4746\$\$ (0.2953)	0.5387\$\$ (0.1614)	1.5574\$\$ (0.2941)	-	-	0.5702\$\$ (0.1932)	-
	Cattle labour	-0.8053\$ (0.3143)	-	-	-0.3066 (0.2393)	0.4851\$ (0.1476)	-	0.2402 (0.2204)	0.2834\$\$ (0.0925)
	Seed	-	-	0.4872\$ (0.1761)	-	0.4132\$ (0.1449)	1.0307\$\$ (0.3195)	-	0.6674\$\$ (0.0925)
	Manure	-	-	-	-	-	-	-	-
	Fertilizer	-0.8107\$ (0.3476)	-	-	-0.3247 (0.2007)	-	-	0.0456\$\$ (0.0195)	-
	Plant protection	-	-	-	-	-	-	-	-
3.	R2	0.6909	0.6751	0.9621	0.7751	0.8359	0.9702	0.8715	0.9442
4.	Return to scale	0.5196\$	1.4746	1.0259	0.9261	0.8983\$	1.0307\$	0.8559\$	0.9612\$
5.	Geometric Means								
	Output	4425.28	7753.58	10563.82	6471.35	4031.40	5898.66	10778.19	5885.05
	Land	-	-	-	-	-	-	-	-
	Human labour	1950.95	3108.42	4020.57	2675.39	2321.29	3737.30	7267.08	3653.31
	Cattle labour	331.01	555.90	662.73	456.44	532.47	864.26	1511.76	822.80
	Seed	168.24	278.87	328.10	229.57	235.97	335.45	646.42	342.17
	Manure	52.08	15.62	111.36	47.16	195.27	199.86	364.37	226.50
	Fertilizer	449.37	622.29	844.82	579.92	11.13	46.88	175.48	37.57
	Plant protection	-	-	-	-	-	-	-	-

\$ Significant at 5 per cent probability (Figures in parentheses are SE of the coefficients)

\$\$ Significant at 1 per cent probability

Cobb-Douglas Production functions model was used to estimate the resource productivity and returns to scale on adopter and non-adopter farms. The function is specified as follows :

$$Y = a x_1^{b_1} \dots x_7^{b_7} u$$

where

Y = Gross value of output (Rs.)

X_1 = Land (hactares)

X_2 = Human Labour (Rs.)

X_3 = Cattle Labour (Rs.)

X_4 = Seed (Rs.)

X_5 = Manure (Rs.)

X_6 = Fertilizer (Rs.)

X_7 = Plant protection measures (Rs.)

u = Random error

a = Constant and

$b_1 \dots b_7$ are the production elasticities of inputs

The logarithmic transformation, of the function is $\log Y = \log a + b_1 \log x_1 + \dots + b_7 \log x_7 + a$

This equation was fitted with the help of least squares method.

To minimize the effect of multi-collinearity step down regression procedure was followed.

RESULTS AND DISCUSSION

1. Small farms

a) Resource productivity

It is observed from Table 1 that the variables included in the function explained 69 per cent and 83.5 per cent of variation in the gross value of output for adopters and non-adopters, respectively. The regression coefficients of cattle labour and fertilizers were -0.80 and -0.81, respectively and these were significant in the case of adopters. It showed that these inputs were excessively used and

warrants to rationalisation. The gross income would fall by 0.8 per cent if the expenditure on cattle labour increased by 1 per cent. On the contrary the regression coefficients of cattle labour was highly significant in the case of non-adopters, which indicated that one per cent increase in the cattle labour would result in increasing the gross value of output by 0.48 per cent. Similarly, the regression coefficient of seed in case of non-adopters was highly significant and it showed that one per cent increase in the seed would result in an increase 0.41 per cent in the gross value of output.

b) Returns to scale

The sum of regression coefficients in Cobb-Douglas function indicates the returns to scale. The sum of regression coefficients was tested against unity. It was observed that diminishing returns to scale were operating on small farms of adopters, while constant returns to scale were operating in the case of non-adopters.

c) Resource-use efficiency

The marginal value products, opportunity costs and ratios of MVPs to OC for paddy are presented in Table 2.

The utilization of human labour, cattle labour and fertilizers were not optimum because the ratios of MVP to OC were not equal to one in the case of adopters. The ratios of MVPs to OC were -10.77 and -7.98 for cattle labour and fertilizer. Cattle labour and fertilizer were used excessively and hence the use of these inputs were to be curtailed to get higher returns. The use of human labour should be increased, as every one rupee spent on this input would increase the gross returns by Rs. 4.82.

In the case of non-adopters, the ratios of

Table 2 : Marginal value Products Opportunity Costs and Ratios of MVP to OC Paddy (Value in Rupees)

Sl.No	Particulars	Small	Medium	Adopters Large	Overall	Small	Medium	Non-adopters Large	Overall
1.	Marginal Value Products								
	Land	-	-	-	-	-	-	-	-
	Human labour	4.826	3.678	1.415	3.767	-	-	0.846	-
	Cattle labour	-10.766	-	-	-4.347	3.673	-	1.712	2.027
	Seed	-	-	15.686	-	7.059	18.124	-	11.478
	Manure	-	-	-	-	-	-	-	-
	Fertilizer	-7.983	-	-	-3.623	-	-	2.801	1.629
	Plant protection	-	-	-	-	-	-	-	-
2.	Opportunity Costs								
	Land	-	-	-	-	-	-	-	-
	Human labour	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Cattle labour	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Seed	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Manure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Fertilizer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Plant protection	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.	MVP to OC ratio								
	Land	-	-	-	-	-	-	-	-
	Human labour	4.826	3.678	1.415	3.767	-	-	0.846	-
	Cattle labour	-10.766	-	-	-4.347	3.673	-	1.712	2.027
	Seed	-	-	15.686	-	7.059	18.124	-	11.478
	Manure	-	-	-	-	-	-	-	-
	Fertilizer	-7.983	-	-	-3.623	-	-	2.801	1.629
	Plant protection	-	-	-	-	-	-	-	-

MVP to OC were 3.67 and 7.06 for cattle labour and seed, suggesting the need to increase the use of these two inputs.

2. Medium farms

a) Resource productivity

It was observed that human labour was the only independent variable which significantly affected the output. The regression coefficient of human labour was 1.47.

In contrast to this, seed was the only independent variable input, whose regression coefficient was 1.03 in the case of non-adopters.

b) Returns to scale

It was observed that constant returns to scale were prevailing in the case of both adopters and non-adopters.

c) Resource-use efficiency

The ratio of MVP to OC for human labour was 3.68 indicating that the expenditure on this input had to be increased to obtain higher returns on adopter farms. The ratio of MVP to OC for seed was 18.4, which indicated the need to enhance expenditure on seed to get higher returns on non-adopter farms.

3. Large farms

a) Resource productivity

The coefficient of multiple determination was 0.96, denoting that the independent variables explained about 96 per cent of the variation in the gross value of output on adopter farms. The coefficients of expenditure on human labour and seed were highly significant. The elasticities of production indicated that a one per cent increase in human labour would increase gross income by 0.53 per cent and one per cent increase in seed would increase the gross income by 0.48 per cent.

The variables namely, human labour, cattle labour and fertilizer explained 87 per cent of variation in the output on non-adopter farms. The production elasticities of human labour and fertilizer were 0.57 and 0.04, indicating determining factor returns.

b) Returns to scale

Constant returns to scale were prevailing both on adopter and non-adopter farms.

c) Resource-use efficiency

The ratios of MVP to OC were 1.42 and 15.69 for human labour and seed respectively, which were more than one. Therefore, the expenditure on these two inputs has to be increased, as this would result in higher returns on adopter farms. However, the ratio of MVP to OC for human labour on non-adopter farms was 0.85, which was less than one. Hence, the expenditure on this input has to be curtailed. The ratios of MVP to OC for cattle labour and fertilizer were 1.71 and 2.80 and hence, there was need to increase the expenditure on these inputs to obtain higher returns on non-adopter farms.

4. Over-all situation

a) Resource Productivity

The variables included in the function explained the variation in the gross value of output to the extent of 77 per cent on adopter farms. The regression coefficient of human labour was statistically significant and positive. A one per cent increase in human labour would result in an increase of gross income by 1.56 per cent. The coefficients of cattle labour and manure were negative but not significant.

On non-adopter farms at overall level, cattle labour and seed were found to influence the output. It was observed that there was

differential behaviour of the sub-groups. Hence, the results of the over-all group could not be considered for drawing meaningful inferences.

b) Returns to scale

Constant returns to scale were operating both on adopter and non-adopter farms.

c) Resource-use efficiency

The ratio of MVP to OC for human labour was 3.77 and hence its use had to be increased on adopter farms. The utilization of cattle labour and fertilizer were to be curtailed since the ratios of MVP to OC were -4.35 and -3.62, respectively. The ratios of MVP to OC were 2.03, 11.48 and 1.63 for cattle labour, seed and fertilizer respectively on non-adopter farms. Hence, there was need to increase expenditure on these inputs so as to get higher returns. The overall picture indicated that expenditure on cattle labour and fertilizer had to be curtailed on adopter farms, while the expenditure on cattle labour, seed and fertilizer has to be increased in the case of non-adopter farms to increase the gross returns.

Conclusions and Implications

The variables which influenced the output varied in different groups.

Human labour was found to be dominantly influencing the output in all size-groups on the adopter farms. The use of human labour should be increased and the expenditure on cattle labour and fertilizer should be curtailed on adopter farms. Cattle labour and seed were observed to be influencing the output on particularly on small and medium farms of non-adopters. The expenditure should be increased on cattle labour, seed and fertilizer in case of non-adopters to move towards the optimum level.

The supply of quality seed is of paramount importance. The State Seed Development Corporation should supply quality seed well in time to the farmers. 'Seed banks' have to be established in the villages. Further, there is need to develop single window delivery system to supply critical inputs to the farmers in time. It is also necessary to provide bullock pairs to the small and marginal farmers. Tractor hire custom services may be made available to the farmers. Above all, Extension and Training Programmes should be taken up more intensively to educate the farmers on the use of resources more efficiently for increasing the productivity and profitability.

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Analysis of Profitability of Cotton Cultivation in Warangal District of A.P.

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ABSTRACT

The work has been conducted in Warangal District of Andhra Pradesh. The analysis of input-out ratio revealed the loss incurred by cotton growers. The input-out ratio exhibited a loss of Rs. 0.20 for small farms, Rs. 0.07 on medium farms, 0.09 on large farms for every rupee invested in cotton cultivation. It was found from Break-even analysis that the small farmers would be at equilibrium at a negative output of 40.73 qtls/ha.

Key Words : Cotton Cultivation, Warangal District

Cotton is the most ancient and important commercial crop next only to food grains. Cotton cultivation, its trade, processing, manufacture, exports of raw cotton textile goods etc; provides the means of livelihood to an estimated 60 million people in India. Cotton is the most important commercial leading and oldest of all fibers used by human beings. As a commercial crop, cotton plays a key role in the economy of the world. Cotton is one of the principal crop in India and enjoys a pride of place and unique position in our economy.

MATERIAL AND METHODS

Many cotton farmers in Warangal district had committed suicides because of loss they had incurred in cotton cultivation. This has drawn attention of Government officials, political leaders and strong protest of the farmers from all the corners of the state. Keeping that in view an attempt has been made in this paper to analyse the profitability of cotton cultivation in Warangal

district of Andhra Pradesh. From the district two mandals viz., Parkal and Dharmasagar were selected as they accounted for largest share in area under cotton out of 50 mandals of the Warangal District. A total of 8 villages were selected based on the area 4 from each mandal. All the cotton growers in each selected village were stratified into 3 size groups viz., small (<2 hectares), medium (2-4 hectares) and large farms (>4 hectares) on the basis of operational area under cotton. Forty growers from each mandal villages were selected at random making a total sample of 80 farmers and post classified into different size groups i.e., small farmers (34), medium farmers (26) and large farmers (20). Thus, one district, 2 mandals, 8 villages and 80 farmers formed the material for the study.

The data were analysed to fulfill the objective of profitability is worked out by using input-out ratio (Of/I) and Break even analysis.

Table 1 : Input-output ratios in cotton cultivation according to farm size

Particulars	Gross returns (Rs/ha)	Total cost (Rs/ha)	Prime cost (Rs/ha)	Input-output ratio (I/O) on the basis of cost 'c'	Prime cost	Net loss per investment on basis of Cost C
Small	14307.02	17748.87	14602.49	1 0.80	1 0.97	0.2
Medium	16903.40	18054.93	14818.46	1 0.93	1 1.14	0.07
Large	16951.27	18574.85	15276.91	1 0.91	1 1.10	0.09
Pooled	15603.78	18054.83	14841.29	1 0.86	1 1.05	0.14

Table 2 : Break-even output in cotton cultivation according to farm size

Particulars	Average yield per farm (qtls)	Fixed cost per farm (Rs)	Variable cost per quintal (Rs)	Price per quintal (Rs)	BEO per farm between BEO & Average output (qtls)	Difference
Small	10.27	4589.19	1813.17	1700.50	-40.73	-51.00
Medium	28.48	11395.11	1632.25	1880.00	45.62	17.14
Large	47.7	19280.75	1663.44	1883.1	87.77	40.07
Pooled	25.16	10369.05	1711.97	1847.63	76.73	51.27

Total fixed costs per farm

Break Even Output = ...

Price per quintal - variable cost per quintal

RESULTS AND DISCUSSION

Generally, profitability is worked out by considering the gross returns and total cost. Certain economists had used input-output ratio (O/I) to assess the profitability and some of them also regarded it as Cost-Benefit ratio. Others used the management tool i.e. break-even analysis to study the viability and profitability. In fact the latter is the better tool because it indicates the point of maximum loss and break-even level of output and there by suggests optimum level of operation. Whereas the input-output ratio suggests the returns for every rupee invested in a particular enterprise. In this study both techniques were attempted.

Input-Output ratio/Cost-Benefit ratio in Cotton Cultivation

It is a simple method which explains the returns for every rupee spent on inputs. The input-output ratios were worked out on the basis of total cost (cost C) and prime cost. To take a decision whether to go for cultivation of cotton or not, the prime cost is the most important one. As such, input-output ratio was estimated by considering the total cost and prime cost and the details are presented in Table 1.

It is seen that the input-output ratio for small farms was 1:0.80, for medium farms 1:0.93, for large farms 1:0.91, while it was 1:0.86 for pooled farms. This was computed on the basis

of total costs.

Input-output ratio on the basis of prime cost was 1:0.97, 1:1.1 and 1:1.05 for small, medium, large and pooled farms respectively.

Thus, the above analysis clearly showed more of net loss, specially in the case of small farms, it was Rs. 0.2 for every rupee invested on cotton production. The net loss in the case of medium and large farms was relatively less.

In fact the magnitude of net loss on every rupee of investment on medium and large farms was more or less equal. But the loss has decreased with increase in the farm size. This may be due to greater risk being absolutely with large farms. Thus, the analysis has clearly showed that the cotton cultivation is a losing proposition in these mandals.

Break-even analysis

This tool will be of greater use to find out the direction of total cost and total revenue as the output changes from one level to another.

To locate break-even output, the components considered were total revenue, fixed and variable costs and output produced on the farm. The total revenue is nothing but total value of the produce produced and the value was estimated at the market price and fixed and variable costs were taken from the cost data. The break even output indicated the level of output at which there is neither profit nor loss.

The details of break even output and average output levels are presented in Table 2. The results in Table - 2 revealed the fact that

the farmers are unnecessarily producing the output without getting even marginal profit. Moreover, every farmer who entered into this business is incurring an unparallel net loss of 20 NP for small farms, 7 NP for medium farms and 9 NP for large farms with an overall average of 14 NP for pooled farms. Raha *et al.*, (1986) found cotton to be more profitable than its competing crops.

The break-even analysis revealed unprofitable nature of cotton cultivation in case of small farmers. Cost-Benefit ratio had also confirmed the unprofitable nature of cotton cultivation at present. On observation it was found

that majority of the farmers are using more than the recommended doses of fertilisers and plant protection chemicals. It is advised that they have to cut down the cost of cultivation to get profits by the cotton cultivation.

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Research Note

Relative Profitability of Intercropping Systems in Dryland Agriculture

Key Words : Intercropping, Agriculture, Dryland

Intercropping is usually practiced for yield stability and yield advantage in dryland agriculture (Willey, 1979). Groundnut productivity, in the country especially in dryland agriculture, is low and fluctuates from year to year depending on vagaries of rainfall during the crop season (Anonymous, 1986). Farmers are traditionally growing pigeonpea along with groundnut in different row proportions and to avoid frequent total crop failure. Groundnut + pigeonpea intercropping in 7:1 row proportion appears to be the remunerative under dryland conditions (Chikkanna, 1982).

In the recent past, sunflower has gained importance in Rayalaseema and pearl millet is also grown as intercrop in groundnut in many places. Information on ideal row proportions in groundnut + sunflower and groundnut + pearl millet system may lead to efficient use of resources leading to remunerative dryland farming. Hence, it was felt necessary to study the relative profitability of sunflower and pearl millet as intercrops in groundnut.

A field experiment was conducted during *kharif* 1991-92 on sandy loam soil of Tirupati, (A.P.) to evaluate the profitability of sunflower and pearl millet as intercrops with dryland groundnut in different proportions. Sunflower (Morden) and pearl millet (WC-C-75) were intercropped with groundnut (TMV-2) at 1:1, 2:1, 3:1 and at 4:1 row proportions keeping groundnut

+ pigeonpea (LRG-30) 7:1 system check. The 12 treatment combinations were laid out in randomised block design and replicated thrice. The plant population of component crops in all the treatments was 100 per cent of sole crop populations. The 100 per cent populations of groundnut, pigeonpea, sunflower and pearl millet were 3,33,333; 55,555; 74,074 and 1,48,148 plants ha⁻¹, respectively.

Higher pod yield was due to sole crop of groundnut (Table 1). Reduction of pod yield was more due to intercropping with pearl millet and least due to groundnut + pigeonpea intercropping. Among different ratios, pod yield increased with increase in row proportions from 1:1 to 4:1. Haulm yield followed almost similar trend. Seed yield of sunflower and pearl millet were higher as sole crops. With increase in row proportions from 1:1 to 4:1 there was decrease in seed yields. Stalk and stover yields also followed similar trend.

Groundnut pod equivalents were higher with groundnut + pigeonpea 7:1 system (2103 kg ha⁻¹) followed by groundnut + sunflower at 3:1 (1864 kg ha⁻¹) but was on par with 2:1 and 4:1 ratios of GN+SF. This might be due to optimum pod and seed yields in 3:1 row arrangement of GN+SF as a result of low competition. Pod equivalent yields with groundnut + sunflower intercropping system was relatively higher compared to groundnut + pearl millet intercropping system.

Economics of intercropping systems indicated that maximum gross return of Rs.18,128 ha⁻¹ was with groundnut + pigeonpea 7:1 (Table 2) followed by groundnut + sunflower 3:1 (Rs. 16,036 ha⁻¹). Similar trend was observed in case of net returns. Gross and net returns among different ratios of groundnut + sunflower intercropping system was relatively higher compared to groundnut + pearl millet intercropping system in respective ratios, indicating the profitability of GN + SF system over GN + PM. Among the intercropping systems, 3:1 row arrangement of GN + SF was more advantageous as it recorded maximum gross and net returns. Benefit-Cost ratio was higher with GN+PP 7:1 followed by sole groundnut. Lower net returns of Rs.2335 ha⁻¹ and Benefit Cost ratio of 1.55 was with sole sunflower, indicating no scope for sole crop of sunflower in sandy loam drylands.

Additional net returns due to intercropping over sole groundnut was maximum (Rs.2932 ha⁻¹) with groundnut + pigeonpea 7:1 system followed by GN+SF 3:1 indicating scope for sunflower as an intercrop with groundnut.

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Research Note

Grain Yield, Nutrient Uptake of Rice as Influenced by Different Sources and Levels of Nitrogen

Key Words : Nutrient uptake, Rice, Nitrogen

Rice is the most important staple food crop in India, grown over 42.9 million hectares with a production of 79.6 million tonnes. Among the rice producing states, Andhra Pradesh occupies a prime place with a production of 118.8 lakh tonnes grown over 43.2 lakh hectares. Crop recovery from applied nitrogen seldom exceeds 30-40%. Hence there is a need to find out ways and means for judicious management of applied nitrogen. The present study was undertaken to determine their effect on dry matter production, grain yield, straw yield and nutrient uptake of transplanted rice under ill-drained conditions.

A field experiment was conducted in split-plot design with three replications during *kharif*, 2000 at Agricultural College Farm, Bapatla on ill-drained sandy clay loam soil, with 16 treatment combinations, comprising four main plot treatments *i.e.*, sources of nitrogen (S_1 -Urea, S_2 - Calcium Ammonium Nitrate, S_3 - Urea Ammonium Phosphate and S_4 - Diammonium Phosphate) and four sub plot treatments *i.e.*, levels of nitrogen (F_1 -80kg N/ha¹, F_2 -120kg N/ha¹, F_3 -160kg N/ha¹ and 200kg N/ha¹). The test variety used was BPT 4358 (Surya).

The data revealed (Table 1) that the dry matter production was significantly influenced by the treatments. Diammonium Phosphate, Urea Ammonium Phosphate and Urea were significantly superior over Calcium Ammonium

Nitrate. In Diammonium Phosphate applied plots, more dry matter production was due to more number of tillers. Ammonium Nitrate recorded the lower dry matter accumulation than the urea due to more loss of nitrogen under waterlogged conditions.

Application of 80 kg N ha⁻¹ and 120 kg N ha⁻¹ were found to be at par and application of 120 kg N ha⁻¹ and 160 kg N ha⁻¹ were also at a par. There was a significant increment in dry matter production with increase in level of nitrogen. When nitrogen was applied either at 120 kg N ha⁻¹ or 200 kg N ha⁻¹, the performance of different sources was significantly different. The per cent increase was 37.9, 18.5 and 11.2 per cent with 200, 160 and 120 kg N ha⁻¹ application, respectively over 80 kg N ha⁻¹. Increased nitrogen supply could increase the formation of protein and hence growth sites and sites of assimilates and thus dry matter production (Singh, 1998).

Diammonium Phosphate recorded significantly higher grain yield of 5.46 t ha⁻¹, which was on a par with the Urea Ammonium Phosphate (5.21 t ha⁻¹). An increased grain yield with the application of Diammonium Phosphate was also reported by Roy and Fokou (1991). Application of Urea was found to be significantly superior in producing higher grain yield (4.82 t ha⁻¹) than the Calcium Ammonium Nitrate (4.29 t ha⁻¹). The loss of nitrogen was higher (13.1 per

Table 1 : Drymatter accumulation (gm^{-2}), Grain yield (t ha^{-1}) and Straw yield (t ha^{-1}) of rice as influenced by different sources and levels of nitrogen under ill-drained conditions

Treatments	Dry matter accumulation (gm^{-2})	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Sources of N			
S ₁	1207.0	4.82	5.48
S ₂	1001.8	4.29	6.20
S ₃	1230.0	5.21	6.73
S ₄	1243.2	5.46	7.50
SEM	41.9	0.18	0.35
CD(P=0.05)	144.7	0.53	1.21
CV(%)	12.4	12.8	18.7
Levels of (kg N ha⁻¹)			
F ₁	1001.1	4.49	5.70
F ₂	1113.5	4.70	5.77
F ₃	1186.5	4.99	6.98
F ₄	1381.0	5.79	7.47
SEM	40.8	0.14	0.43
CD(P=0.05)	119.1	0.50	1.27
CV(%)	12.0	10.30	13.25

Table 2 : Nutrient uptake (kg ha^{-1}) by the rice crop as influenced by different sources and levels of nitrogen under ill-drained conditions.

Treatments	Nutrient uptake at harvest		
	N	P	K
Sources of Nitrogen			
Urea	98.6	35.6	185.1
CAN	89.9	33.9	176.5
UAP	114.8	37.3	194.3
DAP	138.6	37.3	194.3
SEM+	8.9	0.8	5.5
CD(P=0.05)	30.8	2.9	NS
CV(%)	13.9	8.1	10.1
Levels of Nitrogen (kg N ha⁻¹)			
80	84.9	31.4	163.1
120	101.9	35.4	184.1
160	110.6	38.4	199.9
200	144.5	39.0	203.2
SEM+	6.4	0.9	4.8
CD(P=0.05)	18.8	2.8	16.5
CV(%)	10.2	9.2	8.8

cent) in Calcium Ammonium Nitrate 70 days after incubation as reported by Sannigrahi and Mandal (1988). Application of 200 kg N ha⁻¹ gave significantly higher grain yield of 5.79 t ha⁻¹. The liberal nitrogen fertilization at higher levels enhanced the nutrient availability, concentration and uptake and resulted in the improvement of total dry matter production and yield.

Application of nitrogen through Diammonium Phosphate produced significantly higher straw (7.50 t ha⁻¹) but on par with Urea Ammonium Phosphate (6.73 t ha⁻¹). The per cent increase was 36.9, 22.8 and 13.1 per cent with Diammonium Phosphate, Urea Ammonium Phosphate and Calcium Ammonium Nitrate, respectively, over Urea. Straw yield is an output of sequential metamorphosis of photosynthates from source to sink. Partitioning of photosynthates in vegetative and reproductive parts goes simultaneously in the later growth phases (Padmaja Rao, 1988).

Application of diammonium phosphate resulted in significantly higher nutrient uptake of nitrogen (Table 2) and phosphorus but the potassium uptake was not influenced by the different sources of nitrogen. This might be due to the lesser loss of nitrogen and better utilization. Among the different levels of nitrogen, application

of 200 kg N ha⁻¹ significantly improved the nutrient uptake over all the other nutrients as reported by Tripathi *et al.*, (1999).

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Research Note

Growth, Yield of Scented Rice (*Oryza sativa*) Under Transplanted Conditions

Key Words : Scented Rice, Growth, Yield

Optimum plant spacing is one of the important front line agronomic packages to tap the yield potential of rice (Rajaratnam and Balasubramanian, 1999). To realize maximum benefit of applied costly inputs and higher yield, timely control of weeds is of paramount importance (Saini *et al.*, 2001). The rising labour cost and lack of availability of labour during critical period warrant an effective and economical weed control practice (Gogoi *et al.*, 2001). Keeping in view of these facts, the present investigation was undertaken to identify the best suited plant spacing and weed management practices to tap the yield potential of scented rice under transplanted conditions of southern Kerala.

A field experiment was conducted during the *rabi* season of 2000-2001 at the College of Agriculture, Vellayani. The experiment field was sandy clay loam in texture, with 58.4% sand, 8.60% silt and 33% clay in top 0-15 cm soil layer and it was high in organic carbon and available phosphorus and medium in available potassium. The trial was laid out in randomised block design with three spacings (15x15, 20x10 and 15x10 cm) and five weed control treatments (weed free check, unweeded control, hand weeding twice at 20 and 40 DAT, anilofos+2,4-DEE 0.40+0.53 kg ha⁻¹ at 6 DAT supplemented with hand weeding at 20 DAT and anilofos+2,4-DEE 0.40+0.53 kg ha⁻¹ at 6 DAT supplemented with 2,4-D sodium 1 kg ha⁻¹ at 20 DAT). Pusa

Basmati-1 was transplanted keeping three seedlings/hill such that 15x15 cm (44 hills m⁻²) would result in 12% less and 15x10 cm (67 hills m⁻²) would result in 34% more than the recommended plant population of 50 hills m⁻² (20x10 cm) for medium duration rice variety grown in the state. The yield attributes and yield were recorded at harvest and the benefit : cost ratio for each treatment combination was calculated, based on the prevailing market rates.

The yield attributing characters like panicle weight, productive tillers per hill, thousand grain weight, filled grains per panicle, sterility percentage, harvest index and weed index could reach the level of significance due to different spacings and weed management practices tried (Table). Panicle weight, sterility percentage and harvest index recorded at 20x10 cm were significantly superior to narrow spacing of 15x10cm. This may be due to more space and nutrients available for the individual plants. Plant spacing of 20x10 cm (S₂) recorded significantly superior thousand grain weight, filled grains per panicle and weed index than 15x15 (S₁) and 15x10 cm (S₃). Weed management practices involving anilofos+2,4-DEE supplemented with either 2,4-D sodium (W₂) performed significantly superior to hand weeding (W₃) in terms of thousand grain weight, filled grains per panicle and weed index. The various treatments resulted in significantly higher grain yield. The data indicated that plant spacing of 20x10 cm excelled

Table : Growth, yield and economics of transplanted scented rice as influenced by different treatments

Treatment	Panicle weight (g)	1,000-grain weight (g)	Filled grains per panicle	Sterility percentage	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index	Weed index	Net income (Rs ha ⁻¹)	Benefit-cost ratio
<i>Spacing (cm x cm)</i>										
S ₁ - 15 x 15 (44 hills m ⁻²)	2.63	23.29	113.25	16.55	3509	6325	0.359	18.88	41853	1.36
S ₂ - 20 x 10 (50 hills m ⁻²)	2.84	23.69	120.15	15.32	3991	7008	0.363	13.83	52009	1.69
S ₃ - 15 x 10 (67 hills m ⁻²)	1.85	22.66	95.11	18.89	3014	5435	0.350	21.62	30418	0.98
CD (P=0.05)	0.207	0.586	3.213	1.415	69.0	120.1	0.0025	0.577		
<i>Weed management practices</i>										
W ₁ - Anilofos+2,4-DEE fb HW (0.40+0.53 kg ai ha ⁻¹)	2.53	23.26	115.37	15.94	3645	6493	0.359	14.85	51371	1.77
W ₂ - Anilofos+2,4-DEE fb 2,4-DNa salt (0.40+0.53 fb 1 kg ai ha ⁻¹)	2.68	23.65	119.95	15.15	3928	6861	0.364	8.06	58209	2.07
W ₃ - HW twice at 20 and 40 DAT	2.38	22.63	104.95	17.62	3378	6102	0.357	21.31	45277	1.54
W ₄ - Weed free check	2.96	24.58	127.46	13.56	4267	7370	0.366	0.00	27508	0.42
W ₅ - Unweeded control	1.64	21.94	79.76	22.31	2305	4455	0.340	46.30	24770	0.93
CD (P=0.05)	0.267	0.338	4.148	1.826	89.1	155.1	0.0033	0.745		

fb- followed by, HW-hand weeding, DAT-days after transplanting.

all other plant spacings tried by registering 13.7% and 32.4% grain yield increase over 15x15 and 15x10 cm. Similar results in medium duration rice was reported by Lourduraj (1999). Among weed management practices, anilofos+2,4-DEE supplemented with 2,4-D sodium (W_2) excelled all other weed management practices adopted by recording 70.4% grain yield increase over the unweeded control and 16.3% over hand weeded check (W_3). The treatment anilofos+2,4-DEE supplemented with hand weeding (W_1) was rated next best with 58.1% grain yield increase over the unweeded control and 7.9% over hand weeded check (W_3).

Hand weeding (W_3) significantly increased grain as well as straw yields compared with weedy check. Superiority of hand weeding could be ascribed to absence of competition from weeds due to frequent elimination of weeds from field and hence better crop growth. Herbicides caused identical increase but statistically higher than hand weeding. Such a yield increase may be attributed to cumulative effect of yield contributing parameters to a commendable level in W_2 compared to W_1 and W_3 . Better efficacy of anilofos+2,4-DEE supplemented with 2,4-D sodium (W_2) was due to the fact that field was badly infested by *Echinochloa colona*, *Echinochloa crus-galli*, *Leersia hexandra*, *Cyperus iria*, *Cyperus difformis*, *Fimbristylis miliaceae*, *Ludwigia parviflora* and *Monochoria vaginalis* which were effectively controlled as evident from lowest weed index and resulted in higher yield attributes. The results are in accordance with findings of Rao (1995). Adopting plant spacing of 20x10 cm and application of

anilofos+2,4-DEE supplemented with 2,4-D sodium (W_2) could result in maximum net returns and higher benefit : cost ratio.

Thus maintaining plant population of 50 hills m^{-2} (20x10 cm) along with weed management practice of anilofos+2,4-DEE 0.40+0.53 kg ai ha^{-1} supplemented with 2,4-D sodium 1 kg ai ha^{-1} may be used as an effective and economically viable practice to achieve increased yield and more profit from scented rice under transplanted conditions.

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Research Note

Evaluation of Pigeonpea Genotypes for Adaptation to Drought under Natural Conditions

Key Words : Pigeonpea, Adaptation, Drought

Pulse crops face intermittent drought during *kharif* and *rabi* and causes considerable reduction in seed yields. Drought causes imbalance of various metabolic processes which in turn leads to length reduction in the development of plant growth. Kuhad *et al.*, (1990) reported that the water stressed pigeonpea plants recorded low rate of photosynthesis. Jirali *et al.*, (1994) stated that there was significant correlation with seed yield and total dry matter and leaf area index in chickpea under receding soil moisture conditions. Hence, the present study was planned to evaluate suitable genotypes for drought under natural conditions.

An experiment was conducted at Regional Agricultural Research Station, Lam, Guntur Andhra Pradesh during *rabi* 1998-99 on black soil. The experiment was laid in randomized block design replicated thrice in plots of 9m x 5m size adopting a spacing of 45 cm x 20 cm. The treatments consists of 10 genotypes LRG 30, ICPL 94062, ICPL 87119, ICPL 131, ICPL 94063, ICPL 85063, ICPL 8863, ICPL 88047, ICPL 332 and ICPL 87051. The recommended dose of fertilizers and timely plant protection measures were taken. There was no rainfall recorded during growth period. The crop thrives only from receding soil moisture condition. The data on growth and yield components, relative water content were recorded.

There was significant difference between varieties for growth and growth characters.

(Table). From the time of sowing to harvesting no rainfall was recorded. The crop comes up only from the residual soil moisture. Among the varieties tested, ICPL 85063 recorded maximum plant height, number of branches and dry matter followed by LRG 30 and ICPL 332 compared to other varieties. The lowest dry matter recorded in ICPL 8963 and ICPL 87119. There was no significant difference between leaf area index and specific leaf weight among the varieties. The highest relative water content was recorded in ICPL 85063 (73%) followed by LRG 30 and ICPL 332 (71.5%). Due to high relative water content, these varieties showed drought tolerance and maintained good growth.

The varieties showed marked differences for yield and yield attributes. The number of pods per plant was highest in ICPL 85063 (108) followed by LRG 30 (98) and ICPL 332 (92). The test weight also maximum in ICPL 85063 which was grown under stress condition. Seed yield obtained from ICPL 85063 was highest (1278 kg/ha) followed by LRG 30 (1241 kg/ha), ICPL 332 (1194 kg/ha) compared to lowest recorded in ICPL 8863 (911 kg/ha) and ICPL 94062 (930 kg/ha). The increased seed yields in ICPL 85063 might be due to higher relative water content (73%), number of pods per plant, test weight and high specific leaf area. The harvest index was highest in ICPL 85063 (40%) compared to LRG 30 (38%). Similar findings were reported by Jirali *et al.*, (1994) in chickpea. This study revealed

Table 1 : Evaluation of Pigeonpea genotypes for adaptation to drought under natural conditions

Genotype	Plant	No. of	Dry	Leaf	Specific	Specific	Relative water	No. of	No. of	100 seed	Seed	Harvest
LRG 30	83.50	11.07	58.77	3.75	0.351	3.05	71.5 (57.73)	98.0	3.60	11.50	1241	38.0
ICPL 94062	78.33	7.73	55.80	2.24	0.209	4.76	63.2 (52.65)	68.0	3.53	7.73	930	30.0
ICPL 87119	82.80 ¹	10.27	54.54	3.48	0.394	2.53	66.0 (54.33)	85.0	3.53	10.27	1000	33.0
ICPL 131	83.00	9.93	56.84	3.18	0.303	3.29	66.3 (54.51)	87.0	3.80	9.93	1074	34.0
ICPL 94063	87.00	10.53	57.51	3.19	0.379	2.63	67.2 (55.20)	92.0	3.67	10.53	1167	35.0
ICPL 85063	92.00	11.53	60.00	3.89	0.397	2.51	73.2 (58.82)	108.0	3.87	11.53	1278	40.0
ICPL 8863	89.33	10.47	52.88	3.12	0.283	3.53	63.5 (52.83)	90.0	3.40	10.47	911	31.0
ICPL 98047	75.00	8.33	55.89	3.02	0.370	2.70	68.0 (55.55)	85.0	3.33	8.33	1056	34.0
ICPL 332	81.00	11.00	59.69	3.83	0.321	3.11	71.2 (57.54)	92.0	3.53	11.00	1194	36.0
ICPL 87051	87.33	10.40	55.80	3.31	0.421	2.37	69.0 (56.17)	90.0	3.70	10.40	920	30.0
C.D. (0.05)	4.58	1.05	3.57	NS	0.051	NS	3.14	11.29	NS	1.05	51.07	4.26

that ICPL 85063 and LRG 30 was found to be suitable for rainfed conditions / upland areas in Krishna - Godavari zone of Andhra Pradesh.

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Figures in parenthesis indicates arcsine transformed values

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Research Note

Study on Effects of Aluminium Toxicity on Seed Germination and Growth in Groundnut (*Arachis hypogaea* L)

Key Words : Aluminium toxicity, Germination, Groundnut

Aluminium toxicity is a major phytotoxic factor limiting crop production on acidic soils through out the world (Wright *et al.*, 1989). Under acidic conditions aluminium can be toxic to plants even at sub micro molar level. Crops grown on acid soils often have limited growth and productivity. One of the major problems in acid soils is aluminium toxicity on plants (Foy, 1974). More over Al toxicity is particularly serious in acid sub-soils where it is difficult to lime and amend the condition. The seed germination was not affected in alfalfa below 100 ppm Al, but at higher concentration the appearance of unifoliate leaf was delayed and its size was reduced. Seedling growth was not retarded at 20 ppm but greatly reduced at 40 ppm and almost completely suppressed at higher concentration (Dessureaux, 1969). Hence, the present study was planned to determine the effects of aluminium toxicity on seed germination and plant growth in groundnut.

A laboratory experiment was conducted during *rabi* 2000-2001 at Department of Plant Physiology, S.V. Agricultural College; Tirupati. The experiment consists of seven treatments and three replications in a randomized block design. The treatments consist of seven levels of aluminium 0,20,40,80,160 and 320 ppm aluminium levels. The variety used for this experiment was JL-24. The seeds were treated with Dithane M-45 to prevent fungal growth during

germination. The petridishes were washed thoroughly and sterilized by keeping in oven for over night at 100°. The seeds were taken in each petridish. The respective Al solution was added to the petridish and kept in germinator for one week. After seven days, germination percentage, root length, plant height, root dry weight, shoot dry weight and total dry matter of plant was recorded. The statistical analysis was done as per the standard procedure (Panse and Sukhatmae, 1978).

The seed germination in groundnut significantly decreased with increase in aluminium (Al) concentration. Maximum germination was observed in control and minimum was at 320 ppm, where as at 640ppm Al concentration no germination was observed. Up to 80 ppm Al level, significant difference was not observed among the treatments (Table 1). Similar results were reported by Dessureaux (1969) in alfalfa. It may be possible that aluminium at lower concentration may not be either influencing the uptake of water (or) interfering with the events preceding germination. However, at higher concentration the effect may be either due to osmotic (or) ionic

The plant height, root length, leaf number decreased significantly with increasing Al concentration but the decrease was not significant between control and 20 ppm. The

Table 1 : Effect of different levels of Aluminium on seed germination, plant height, root length and leaf number in groundnut at 7 DAS (cv. JL-24)

Al level (ppm)	Germination Percentage	% ROC	Plant height (cm plant ⁻¹)	% ROC	Root length (cm plant ⁻¹)	% ROC	Leaf number (Leaves plant ⁻¹)	% ROC
0	93.33	--	6.4	--	14.2	--	4.0	--
20	80.00	14.3	6.2	3.1	13.6	4.2	3.5	12.5
40	73.30	21.4	5.7	10.9	12.5	12.0	3.3	17.5
80	70.00	25.0	5.1	20.3	11.1	21.8	2.6	35.0
160	56.60	39.3	4.7	26.6	8.3	41.5	2.2	45.0
320	46.66	50.0	3.2	50.0	6.9	51.4	2.0	50.0
CD at 5%	10.5		0.373		0.741		0.471	

% ROC = Percent reduction over control

Table 2 : Effect of different levels of Aluminium on plant growth in groundnut.

Al level (ppm)	Shoot dry weight (mg plant ⁻¹)	% ROC	Root dry weight (mg plant ⁻¹)	% ROC	Total dry weight (mg plant ⁻¹)	% ROC
0	5.42	--	0.88	--	6.3	--
20	4.86	10.3	0.67	23.3	5.53	12.2
40	4.21	22.3	0.64	27.3	4.85	23.0
80	3.80	29.9	0.55	37.5	4.35	30.9
160	3.20	40.9	0.36	59.1	3.56	43.5
320	2.10	61.2	0.13	85.2	2.23	64.6
CD at 5%	0.199		0.037		0.600	

% ROC = Percent reduction over control

reduction in the plant height, root length, leaf number was more than 50 per cent at 320 ppm compared to control. The visual symptoms of aluminium toxicity were observed first on primary roots and later on lateral roots of seedlings. The roots of plant with aluminium toxicity also exhibited reduction in root length, increase in root diameter, light brown colour pigments on roots, decrease in lateral root formation and ceased root hair formation. Root became stubby and brittle and is inefficient in absorbing nutrients and water. These results are in conformity with those of Narayanan and Syamala (1986) in pigeon pea. Root growth stunting was probably due to inhibition of cell division and the stubbiness was due to interference of aluminium on the phosphorylation of sugars.

The shoot, root and total dry matter of groundnut seedlings decreased significantly with increase in concentration of Al (Table 2) but the decrease was not significant between 20 and 40 ppm Al. The reduction in shoot, root and total dry matter was more than 60 per cent, 80 per cent and 60 per cent at 320 ppm Al compared to control respectively. Aluminium toxicity caused significant reduction in root dry weight and total dry matter in pigeon pea (Narayanan and Syamala, 1986). Al at higher concentration decreased the dry weight of plant parts due to decrease in soluble carbohydrate including

sugars and decreased synthesis of macromolecular substances such as proteins and nucleic acids. From the above results it can be inferred that Al at 320 ppm caused more than 50 per cent reduction in germination and plant growth in groundnut.

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Research Note

Elemental Composition and Molar Ratios of Some Soils of Singarayakonda Mandal in Prakasam District of Andhra Pradesh

Key Words : Elemental, Molar Ratios

Soils of Singarayakonda mandal consist of black, red and sandy soils. Chemical composition of soils depends on their parent material, stage of weathering and climate of the area. As many as seven pedons were selected for the present study in Singarayakonda mandal.

Singarayakonda mandal comes under semi-arid monsoonic type climate with annual rain fall of 916.23 mm and mean annual temperature of 26.70°C. Seven pedons from 1) Singarayakonda 2) Pakala 3) Potaiharipalem 4) Kalikavayai 5) Bingenipalli 6) Old Singarayakonda 7) Mulaguntapadu were collected and analysed for chemical composition. All these pedons were opened beyond 1m depth. Horizonwise samples were collected from each pedon for laboratory analysis. Chemical composition of the soils was determined by using standard procedures.

All the black and red soils had lesser silica content than sandy soil. Silica content decreased with depth in black and red soils due to removal of weatherable products by leaching. Decrease in SiO_2 content with depth was reported by Diwakar and Singh (1994).

Sandy soils had more silica content and exhibited more or less increasing trend with depth

due to more sand content in sub-surface horizons. Soils formed from sand stone were more siliceous in nature due to their quartz content (Walia and Rao, 1997). Silica showed significant positive correlation ($r: +0.88$) between sand and silica contents.

In case of black and red soils pedons content varied from 13.00 to 23.50 per cent. Sandy Soil (Pedons) showed the lowest value of 13.00 per cent. More or less and increasing trend of Al_2O_3 and R_2O_3 was observed with depth in all pedons except sandy soil pedon. Major fraction in sesquioxides content was alumina. Similar results were noticed by Singh *et al.*, 1991. Sandy soils had very less alumina content because they had major contribution of sand. Iron oxides content varied from 1.80 to 5.26 per cent. Red soils (Pedon 1,6 and 7) showed high iron oxide, which was due to chemical composition of the parent material.

Molar ratios of $\text{SiO}_2/\text{R}_2\text{O}_3$, $\text{SiO}_2/\text{R}_2\text{O}_3$, $\text{SiO}_2/\text{Al}_2\text{O}_3$, were broad in all the soils in particular in sandy soils which might be due to siliceous nature of the soil. These results were in accordance with the studies of Tiwary and Mishra (1992).

Table 2 : Effect of different levels of Aluminium on plant growth in groundnut.

Horizon & pedon No.	Depth (m)	Molar Concentrations				Molar Ratios			
		SiO ₂	Fe ₂ O ₂	Al ₂ O ₂	R ₂ O ₂	SiO ₂ / R ₂ O ₂	SiO ₂ / Fe ₂ O ₂	SiO ₂ / Al ₂ O ₂	SiO ₂ / R ₂ O ₂
1. AP	0.00 - 0.09	1.06	0.027	0.11	0.15	7.06	9.63	39.25	4.07
AP ₂	0.09 - 0.25	1.00	0.026	0.14	0.16	6.25	7.14	38.46	5.38
Bt ₁	0.25 - 0.42	0.95	0.030	0.14	0.18	5.27	6.78	31.66	4.60
Bt ₂	0.42 - 0.69	0.93	0.027	0.15	0.18	5.16	6.20	34.44	5.55
C	0.69 - 1.18	0.91	0.027	0.16	0.19	4.78	5.68	33.70	5.92
2. AP	0.06-0.06	1.00	0.024	0.14	0.17	5.88	7.14	41.66	5.83
B	0.06-0.39	0.97	0.023	0.15	0.17	5.70	6.46	42.17	6.52
Bss ₁	0.39-0.65	0.95	0.023	0.15	0.17	5.58	6.33	41.30	6.52
Bss ₂	0.65-0.92	0.93	0.025	0.15	0.18	5.16	6.20	37.20	6.52
Bss ₃	0.92-1.42	0.90	0.024	0.16	0.19	5.74	5.62	37.50	6.66
AC	>1.24	0.88	0.023	0.17	0.19	4.63	5.17	38.26	7.39
3. AP	0.00-0.08	0.94	0.027	0.15	0.18	5.22	6.26	34.81	5.55
B ₁	0.08-0.32	0.91	0.026	0.15	0.18	5.08	6.06	35.00	5.76
B ₂	0.32-0.64	0.91	0.024	0.16	0.19	5.08	5.68	37.91	6.66
Bw ₁	0.64-0.77	0.88	0.024	0.16	0.19	4.63	5.50	36.66	6.66
Bw ₂	0.77-1.08	0.88	0.025	0.17	0.19	4.52	5.05	34.40	6.80
4. AP	0.00-0.11	1.00	0.026	0.14	0.17	5.88	7.14	38.46	5.38
Bw ₁	0.11-0.24	0.98	0.024	0.15	0.17	5.76	6.53	40.83	6.25
Bw ₂	0.24-0.52	0.96	0.024	0.14	0.17	5.64	6.85	40.00	5.83
Bss ₁	0.52-0.87	0.95	0.021	0.16	0.19	5.93	5.93	45.23	7.61
Bss ₂	0.87-1.32	0.85	0.020	0.18	0.21	4.04	4.72	40.47	9.00
AC	1.32+	0.83	0.018	0.20	0.22	3.77	4.15	46.11	11.11
5. AP	0.00-0.09	1.18	0.012	0.10	0.11	10.72	11.80	98.33	8.33
AB	0.09-0.34	1.15	0.012	0.11	0.13	8.84	10.45	95.33	9.16
C ₁	0.34-0.69	1.05	0.011	0.11	0.12	9.58	10.45	104.54	10.00
C ₂	0.69-0.94	1.19	0.012	0.13	0.14	7.78	8.38	90.83	10.83
C ₃	0.94-1.36	1.16	0.011	0.11	0.12	9.66	10.54	105.45	10.00
C ₄	1.36+	1.16	0.011	0.10	0.11	10.54	11.60	105.45	9.09

(Contd....)

Horizon & pedon No.	Depth (m)	Molar Concentrations				Molar Ratios			
		SiO ₂	Fe ₂ O ₂	Al ₂ O ₂	R ₂ O ₂	SiO ₂ / R ₂ O ₂	SiO ₂ / Fe ₂ O ₂	SiO ₂ / Al ₂ O ₂	SiO ₂ / R ₂ O ₂
6. AP	0.00-0.16	0.99	0.028	0.140	0.19	5.21	7.07	35.35	5.00
AB	0.16-0.54	0.96	0.031	0.140	0.18	5.33	6.85	30.96	4.51
C ₁	0.54-0.78	0.95	0.032	0.144	0.18	5.27	6.59	29.68	4.37
C ₂	0.78-1.02	0.91	0.027	0.168	0.19	4.78	4.51	33.70	5.92
C ₃	1.02-1.27	0.89	0.027	0.168	0.19	5.23	5.29	32.96	5.91
C ₄	1.27+	0.86	0.028	0.170	0.20	4.30	5.05	30.71	6.01
7. AP	0.00-0.11	1.01	0.017	0.15	0.17	5.94	6.73	59.41	8.82
Bw ₁	0.11-0.35	0.92	0.019	0.16	0.18	5.11	5.76	48.42	8.42
Bw ₂	0.35-0.72	0.91	0.019	0.17	0.19	4.78	4.78	47.89	8.94
Bt ₁	0.72-1.12	0.90	0.018	0.18	0.19	4.73	4.73	50.00	10.00
C	>1.12	0.90	0.017	0.18	0.19	4.73	4.73	52.94	10.58

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Research Note

Micro Nutrient Status of Some Rice Soils of Andhra Pradesh

In Andhra Pradesh, rice is the most important crop occupying an area of 3.97 m ha, which accounts to 2/3 of the cultivated area with a production of 9.90 mt and ranks third in fertilizer consumption per unit gross cropped area (135.58 kg ha⁻¹). It is extensively cultivated in the Krishna - Godavari Zone, Nagarjuna Sagar Project area and other coastal districts under intensive rice - rice cropping sequence. Imbalance use of fertilizers and intensive cropping leads to deficiency of micronutrients, which limits the crop productivity. In order to assess the micro nutrient status, thirty two soil samples from intensively rice growing soils representing eight districts of Andhra Pradesh were collected randomly and analysed for p^H, EC and available (DTPA extractable) micro nutrients.

The rice growing soils are mostly clay loam to clay in texture, neutral in reaction (p^H 6.4-8.2) and non-saline (EC 0.14-2.23 dS m⁻¹). The DTPA extractable micronutrients in these soils (Table 1) are in the order of Fe > Mn > Cu > Zn.

Iron : The available Fe content of these soils ranged from 3.4-62.9 mg kg⁻¹ with a mean value of 21.4 mg kg⁻¹. Almost all the soils were found to be higher than the critical limit (4.0 mg kg⁻¹).

Manganese : The available Mn status of these rice soils varied from 2.8-47.8 mg kg⁻¹,

Table : Available micronutrient status of rice soils of Andhra Pradesh

Sl. No.	Zone	District	No. of Soils	pH	EC (dS m ⁻¹)	Available micronutrients (mg kg ⁻¹)			
						Fe	Mn	Zn	Cu
1.	K.G. Zone	East Godavari							
		West Godavari	17	6.5-7.7 (7.1)	0.19-2.23 (0.67)	4.7-62.8 (21.9)	6.3-47.8 (19.4)	0.39-1.84 (0.75)	1.32-2.86 (2.08)
		Krishna							
		Guntur							
2.	N.S.P.area	Nalgonda	4	7.3-7.8 (7.6)	0.20-0.62 (0.31)	3.4-10.0 (8.0)	2.8-5.6 (4.2)	0.27-0.79 (0.46)	0.44-0.74 (0.54)
3.	Coastal	Srikakulam	8	6.4-7.8 (7.2)	0.14-1.03 (0.38)	9.3-62.9 (30.9)	5.1-14.7 (9.2)	0.39-2.32 (1.00)	0.64-1.59 (1.09)
	Nellore								
4.	Telangana	Rangareddy	3	7.7-8.2 (7.9)	0.30-1.34 (0.71)	8.4-12.4 (10.8)	5.3-6.2 (5.7)	0.55-1.71 (1.32)	0.94-1.74 (1.23)

Parentheses indicate the mean values

with a mean of 13.7 mg kg^{-1} . None of the soils found deficient in DTPA-Mn ($<2.0 \text{ mg kg}^{-1}$).

Zinc : The DTPA-Zn content varied from $0.27\text{-}2.32 \text{ mg kg}^{-1}$, with a mean value of 0.83 mg kg^{-1} , which is very close to the critical limit (0.80 mg kg^{-1}). Of the total soils, majority of soils (72%) were deficient in Zn. The Zn deficiency in the soils was in the order of K.G.Zone > N.S.P.area > Coastal area > Telangana. In some soils the Zn level is as low as 0.27 mg kg^{-1} (N.S.P.area), whereas in other soils (Coastal area) it is as high as 2.32 mg kg^{-1} .

Copper : The available Cu in these rice soils ranged from $0.44\text{-}2.86 \text{ mg kg}^{-1}$ with a mean of 1.56 mg kg^{-1} . All the rice soils under the study

were found to be higher than the critical limit of DTPA-Cu (0.2 mg kg^{-1}).

The study on micro nutrient status of intensively rice growing soils of Andhra Pradesh revealed that the Zn deficiency was severe in Krishna - Godavari Zone, Nagarjuna Sagar Project area and other coastal districts, which needs the regular application of ZnSO_4 @ 50 kg ha^{-1} along with balanced NPK fertilizers in order to sustain the rice yields. Except Zn, other micronutrients (Fe, Mn & Cu) are well above the critical limits in these rice soils. Soils have to be tested periodically to assess the micronutrient status and suitable remedial measures should be followed.

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Research Note

Feeding Behaviour and Orientation Response of Sesame Pod Bug, *Elasmolomus sordidus* Fabricius

Key words : Sesame Pod bug, Feeding behaviour, Orientation response

The lygaeid bug, *Elasmolomus sordidus* Fab. was reported as a post-harvest pest of sesame occurring on the harvested sesame plants in the thrashing floor for feeding. It was also observed that bugs were feeding on the green pods in the field. It sucks sap from the seeds of sesame and caused reduction in seed weight and oil content (Mohanasundaram and Sundara Babu, 1987). Feeding behaviour has been conceived as a complex and interacting sequence of response to a variety of stimuli culminating in ingestion to satiation (Thorpe *et al.*, 1947; Dethier, 1947). Before actual feeding, there is host selection by insect which involves a catenary process consisting of a chain of responses to different stimuli like chemical, visual, tactile, etc., each of which is received as a result of the insect making previous responses in the chain (Sanjayan and Ananthakrishnan, 1987). Ananthakrishnan *et al.*, (1983) and Sanjayan and Ananthakrishnan, (1987) studied the feeding behavior of *E. sordidus* and they reported that the sequential behaviour comprising, (1) Characteristic movement in search of food and orientation towards food source, (2) Food seed perception by antenna and tarsus, (3) Rostral probe and sensillar recognition, (4) search for suitable feeding site, (5) Stylet insertion and (6) Intense feeding.

The establishment of insects on plants is governed by a number of factors involving

responses of the insect to plant as well as plant characteristics eliciting these responses (Saxena, 1969). Raman (1988) studied the orientation response of *Oxycarenus laetis* towards different malvaceous seeds and reported that the orientation towards fresh pods was more than towards dry pods to feed on the mature seeds. With this background the studies on the feeding behavior and orientation response of *E. sordidus* was carried out.

Feeding behavior of pod bug was observed by allowing the adult bugs to feed on sesame capsules in the tubular mylar film cage (45 x 6 cm) under the laboratory condition. The feeding preferences of pod bug in relation to stage of the crop and part of the capsules were also investigated both in the field as well as in laboratory conditions. A total of twenty five plants randomly selected in the field were tagged during flowering and observed for the incidence of pod bug from 40 days after sowing (DAS). Bug population on different stages of pod maturity, namely tender (40-60 DAS), half matured (61-75 DAS) and matured (76-90 DAS) pods were recorded daily on these 25 plants.

Both nymphs and adults were found to feed on the capsules in the field, only during the night hours. The feeding usually started at dusk and continued throughout the night till dawn. The advent of the sun in the morning made the insects move quickly and hide under the weeds

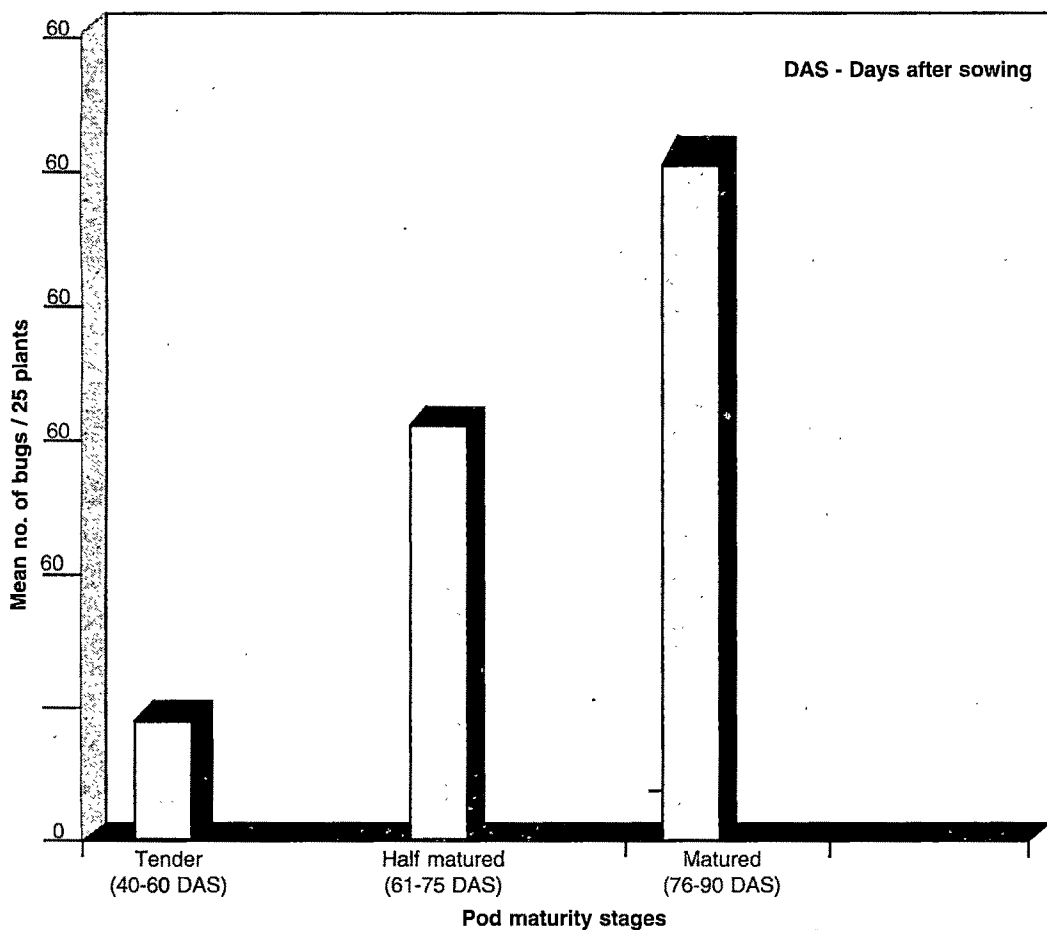
or rubbish materials or in the cracks and crevices in the soil under field condition. They were observed to lead a concealed life during day hours.

In the laboratory, observations were made on the feeding behavior of the bugs. Initially, they performed up and down wafting movements of the antennae to enable their orientation towards the food source. Then the bugs perceived the food source by the antennal and tarsal sensilla. After the food source

recognition, the insects settled on the capsules and then started feeding by inserting their stylets into the capsule. After feeding process was over, the bugs cleaned their antennae and rostrum with their forelegs. It was observed that the bug produced stylet sheath during their feeding.

The present observations on feeding behaviour of the pod bug on sesame agreed with the earlier report of Sanjayam and Ananathakrishnan (1987). They reported the formation of a stylet sheath during feeding by *E.*

Table 1 : Orientation response of the pod bug *Elasmolomus sordidus* to sesame pods



sordidus on groundnut seeds. When the feeding was completed the excess salivary fluid dried up leaving cone like structures on the seed surface. In the present study also stylet sheaths were noticed on sesame capsule fed by the pod bugs.

In the field the number of bugs that visited the plants of tender pod stage ranged from 2.0 to 9.0 with a mean of 4.84 bugs per 25 plants. The half matured pod stage recorded 28.0 to 50.0 bugs with a mean of 37.52 while the matured pod stage recorded 39.0 to 71.0 bugs with a mean of 55.12, bugs per plant. Among the three stages, the tender pod stage, recorded the lowest number of bugs followed by half matured and matured stage (Fig 1).

Raman (1988) studied the orientation responses of *Oxycarenus laetus* towards different malvaceous seeds and reported that the orientation towards fresh pod was more, than towards the dry pods to feed on the mature seeds. Even though a general orientation pattern of *O. laetus* was observed towards green pods initially, the nymphs and adults exhibited more preference for dry pods with mature seeds since they were the main source of food. In the present sesame pod bug also it was observed that the bugs preferred half matured and matured pods to tender pods, which was confirmed by the orientation response of *E. sordidus* more towards matured pods than towards tender pods.

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Research Note

Effect of Certain Pesticides on The Predatory Beetle, *Harmonia SP.*

Biological Control or the use of natural enemies of pests such as; parasites, predators and pathogens is an important component in Integrated Pest Management (IPM) to keep the pests below economic injury level and maintain an ecological balance. Potentially more important form of biological control is the manipulation of indigenous or established natural enemies in cropping systems where chemical control is still the dominant pest control measure. New plant protection chemicals entering the markets challenge the ability to integrate biological and chemical control. Unscientific integration of pesticides with biological agents will lead to a failure in plant and environmental protection. Therefore, knowledge on the interaction of pesticides with natural enemies is essential for the development of reliable IPM techniques.

Harmonia sp is an indigenous coccinellid predator commonly found in horticultural crops. The adults as well as grubs feed on soft bodied insects mostly aphids.

To evaluate the effect of pesticides on the predator, *Harmonia* sp., dry film contact method was followed. Clean petri dishes were taken. The inner surface of both the bottom and cover of the petri-dish was treated with pesticide. One millilitre of the recommended concentration of pesticide was sprayed by using a Potter's tower. The treated surface was allowed to dry at

room temperature. The adult beetles collected from vegetable fields were conditioned for about 3 hours in the laboratory and then introduced into the treated petri-dishes. Twenty adult insects were used for each treatment with five replications. Water treatment was used as control. After 30 minutes of exposure on the treated surface the beetles were transferred to untreated petri-dishes and the mortality was recorded 48 hours after treatment. The beetles were fed on the Honey - agar medium provided on a piece of cardboard.

The data showed that the mortality percentage of the adult predatory beetle, *Harmonia* sp., after 48 hours of treatment was as high as 97% in quinalphos, 96% in carbaryl and 91% in monocrotophos and the least mortality was found in diflubenzuron (7%) and methofenozide (7%). Endosulfan and tebufenozide showed 8% and 9% mortality respectively. The order of the relative mortality to *Harmonia* sp was quinalphos > carbaryl > monocrotophos > tebufenozide > endosulfan > diflubenzuron = methofenozide. It is seen from the Table that the organophosphatic insecticides (quinalphos, monocrotophos) and carbamate (carbaryl) caused greater toxicity to adult beetles. Insect growth regulator (diflubenzuron), the two insect moult accelerating compounds (tebufenozide, methofenozide) and the organochlorine insecticide, endosulfan were found to cause less than 50% mortality.

Table 1 : Effect of certain pesticides on the predatory beetle, *Harmonia sp.*

Pesticide	Concentration (%)	No. of Insects treated	Mortality (%) after 48 hours
Carbaryl	0.15	100	96
Diiflubenzuron	0.02	100	7
Endosulfan	0.07	100	8
Methofenozide	0.01	100	7
Monocrotophos	0.06	100	91
Quinalphos	0.05	100	97
Tebufenozide	0.02	100	9
Control	---	100	5

These results are in conformation with earlier observations made by Rao *et al.*, (1990) and Sharma *et al.*, (1991) who reported the toxic effects of certain pesticides to the predator.

Sharma *et al.*, (1991) stated that dimethoate and monocrotophos were highly toxic to coccinellid predators. Rao *et al.*, (1990) reported that pyrethroids were highly detrimental to the predators.

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Research Note

Suitability of Rice Varieties for Direct Seeding under Late *Kharif* Conditions

Key Words : Rice Varieties, Late *Kharif*, Direct Seeding

In Southern Telangana Zone of Andhra Pradesh, long duration variety BPT 5204 is the choice variety in the *kharif* season for majority of farmers due to excellent grain quality. In most of the areas under tanks and wells, rice nurseries are generally sown in the normal aged (30 days) seedlings. Most of the times, monsoon is not setting in time, which is erratic. So, the filling up of tanks and recharging of wells is getting delayed which is necessitating the farming community to prepare main field late and ultimately resulting in planting with aged (50-70 days) seedlings. The BPT 5204 planted with aged seedlings do not produce more tillers and the crop is very much subjected to pest and disease infestation resulting in reduction in grain yield upto 52% (Sivasankara Rao and Kulkarni, 1996). Under such delayed conditions, direct seeding of short duration varieties like Tellahamsa and Rasi have been reported to perform as good as transplanted rice crop with normal age of seedlings. It is therefore, necessary to study whether direct seeding of short duration varieties can be an alternative to planting of 60 to 70 days aged seedlings of BPT 5204.

A field study was conducted at Agricultural Research Institute, Rajendranagar during late *kharif* 1999. The treatments consisted of planting 60 and 70 day aged seedlings of BPT 5204 and direct seeding of short duration varieties

(Tellahamsa, Satya, Rajendra and Heera). BPT 5204 nursery was sown on 9-6-1999 and 18-6-1999 to obtain 60 and 70 day aged seedlings respectively by 19-8-1999. BPT 5204 was transplanted on 19-6-1999. On same day, sprouted seeds of Tellahamsa, Satya, Rajendra and Heera were broadcasted @ 100 kg ha⁻¹. All the recommended cultural and management practices for planting aged seedlings of BPT 5204 were followed. For both the direct seeded and transplanted crop, a common fertilizer dose of 100 kg N + 60 kg P₂O₅ + 40 kg K₂O ha⁻¹ was applied. For transplanted crop (aged seedlings), 2/3 of N was given along with entire P₂O₅ and K₂O were as basal while for direct seeded crops, 10 kg N + entire P₂O₅ and K₂O were given at the time of sowing. The remaining dose of nitrogen was given at 20 days after planting for aged seedlings while it was given in three equal installments at 20 days after planting for aged seedlings while it was given in three equal installments at 20, 40 and 60 days after sowing for the direct seeded crop. The experiment was conducted in randomized block design with 4 replications. The soil was sandy loam in texture with soil reaction of 8.2 pH and EC 0.33 m.mhos cm⁻¹ and medium in fertility (210.0 N, 15.5 P₂O₅ and 227 K₂O kg ha⁻¹).

Perusal of the data on grain yield and ancillary characters (Table) revealed that direct seeding of Tellahamsa gave highest grain yield

Table : Studies on suitability of rice varieties for direct seeding under take *kharif* conditions

Treatments	Plant height (cm)	Panicles sqm^{-1}	Panicle wt (g)	Grains panicle $^{-1}$	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	B:C ratio
T ₁ Planting 60 days aged seedlings of BPT 5204	65.0	364.5	2.68	154.5	3.72	5.45	1.59
T ₂ Planting 70 days aged seedlings of BPT 5204	64.0	324.0	2.58	140.7	2.76	4.45	1.20
T ₃ Direct seeding of Satya	87.4	382.0	2.70	122.5	3.92	5.65	1.64
T ₄ Direct seeding of Rajendra	70.5	340.0	2.78	109.0	2.97	4.65	1.26
T ₅ Direct seeding of Tellahamsa	84.0	381.0	2.85	106.5	4.02	5.71	21.68
T ₆ Direct seeding of Heera	73.5	314.5	2.63	102.5	2.70	4.10	1.14
SEm+	3.8	16.7	0.11	8.7	0.47	0.21	
CD ($\bar{P}=0.05$)	11.4	50.5	NS	26.4	0.92	0.72	

Note :

Cost of paddy Rs. 450 quintol $^{-1}$ for Satya, Rajendra, Tellahamsa and Heera

Cost of paddy Rs. 500 quintol $^{-1}$ for BPT 52004

Cost of paddy straw Rs. 300 tonne $^{-1}$

Cost of cultivation of T₁ and T₂ Rs. 12750 ha $^{-1}$

Cost of cultivation of T₃ to T₆ Rs. 11750 ha $^{-1}$

(4.02 t ha $^{-1}$) and was significantly on par with direct seeding of Satya (3.92 t ha $^{-1}$) and planting 60 days aged seedlings of BPT 5204 (3.72 t ha $^{-1}$). This was attributed to more number of panicles sqm^{-1} and number of grains panicle $^{-1}$. Planting 70 day aged seedlings of BPT 5204 produced less number of panicles sqm^{-1} and panicle weight resulted in drastic reduction in grain yield (2.76 t ha $^{-1}$). Lowest number of panicles sqm^{-1} and number of grains panicle $^{-1}$ were reported by direct seeding of Heera finally resulting in lowest grain yield (2.7 t ha $^{-1}$) and straw yield (4.1 t ha $^{-1}$). Benefit : cost ratio was found to be highest (1.68) due to direct seeding of Tellahamsa followed by direct seeding of Satya (1.64) and planting 60

days aged seedlings of BPT 5204 (1.59) indicating economic feasibility of direct seeding.

These results suggest that under *kharif* conditions, instead of planting more than 60 day aged seedlings of BPT 5204, direct seeding of short duration varieties like Satya or Tellahamsa may be resorted to for realising maximum production.

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Research Note

Correlation Study for Yield and Yield Attributing Characters of Betelvine (*Piper betle* L.)

Key Words : Correlation, Yield, Betelvine

Betelvine (*Piper betle* L.) is an important cash crop of Andhra Pradesh grown in an area of 3,865 ha. The betelvine is highly labour intensive crop and thus best suited to small holdings. Usually the betelvine is marketed in the units of leaves in local markets of Andhra Pradesh. Information on the relationship between yield, (number of leaves per vine) with its yield attributing characters is not available. Hence an attempt was made to study the correlation coefficients between leaf yield and its yield components.

An experiment was conducted at Betelvine Research Station, Chintalapudi during 2001-02 on clay loam soils with Kapoori type. Uniform recommended package of practices were followed in all the plots. Observations on vine elongation, number of laterals per vine, internodal length, 100-leaf weight and leaf area were collected and correlation coefficients were tested by comparing correlation coefficients with the table value (Fisher and Yates, 1963) at (n-2) degrees of freedom at 5% and 1% level, where 'n' is the number of paired observations used in the calculation.

Data presented in Table showed significant positive association between yield (number of leaves per plant) and vine elongation (0.6927**). Similarly the number of laterals showed significant positive association with yield

Table : Correlation coefficient values between yield and yield attributing factors

	Vine elongation	Number of laterals/vine	Inter nodal length	'100'-leaf weight	Leaf area
Vine elongation					
Number of laterals/Vine	0.3378				
Internodal length	-0.0989	-0.9180**			
100-leaf weight	0.6522**	-0.2397	0.5280		
Leaf area	0.6240	-0.3282	0.5924*	0.8579*	
Leafy yield/vine	0.6927**	0.7542**	-0.5011	0.3314	0.3110

r table value for 28 df at 5% level of significance = 0.514*
1% level of significance** = 0.641**

(0.7542**) which was in tune with the findings of Ramakrishna and Rao (1992) in betelvine. These observations from the data revealed that vine elongation and number of laterals per vine might have contributed for increasing leaf yield. Vine elongation exhibited significant positive correlation with 100-leaf weight (0.6522**), leaf area (0.6240*) and leaf yield per plant (0.6927**). Internodal length showed significant positive correlation with vine elongation (0.6522**). Leaf area showed significant positive correlation with vine elongation (0.6240*), internodal length (0.5920*) and 100-leaf weight (0.8579**). Hence number of laterals per vine, vine elongation (Ramakrishna and Rao, 1992) and internodal length (Ramakrishna and Reddy, 1996) in betelvine can be taken as dominant yield components controlling the yield diversity in betelvine.

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A Study on The Assessment of Level of Participation of Beneficiaries in Watershed Development Programmes of Governmental Organisation and Non-Governmental Organisation

Key Words : Watershed Development, Governmental and Non-Governmental Organisation

Participation of people involved in developmental Programmes is often seen as a way to make these programmes more successful, especially for solving problems of poor people. Thus people's participation is the active process of involvement of the beneficiaries in deciding the activities of development programme, fixing gap priorities, taking initiative and executing the programme as partners along with their ideas, interest, money, land, labour and time and sharing equitably the benefits there on. Hence peoples participation is considered to be an important component for successful implementation of a programme. Keeping such in view the present study was designed to find out level of participation of beneficiaries in WSDP's of GO and NGO.

Ex post-facto research design was used in the present investigation. The sample consisted of 120 beneficiaries *i.e.* 60 each from GO and NGO. The participation in the present study referred to the "Dynamic group process in which all members of a work group involve, contribute, share or influence by the interchange of ideas and activities of WSDP. The scale developed by Reddy (1996) with suitable modifications was used in the present study to assess the level of participation of the beneficiaries in the WSDP.

The participation scale consisted of 20

statements. The beneficiaries were asked to indicate their degree of agreement for each item of the scale on three point continuum. Fully Participated (FP), Partly Participated (PP) and Not Participated (NP) and the scores assigned were 2, 1 & 0, respectively, which were added to compute participation score of each beneficiary. The minimum and maximum possible score were 0 & 40 respectively. The beneficiaries were grouped into three categories based on the participation scores obtained duly following the usual procedure by adopting mean and standard deviation *viz.*,

1. Low - Below (Mean-SD)
2. Medium - Between (Mean-SD) to (Mean+SD)
3. High - Above (Mean + SD)

It was evident from the Table that 70 per cent of the beneficiaries had medium level of participation followed by low (18.33%) and high (11.67%) in case GO, whereas in NGO 68.33 per cent of the beneficiaries had high level of participation followed by medium (16.67%) and low (15.00%). The above results clearly indicate that majority of the beneficiaries had medium level of participation in GO, whereas high level of participation in NGO was recorded.

The high level of participation in NGO, might be due to the fact that the beneficiaries of

Table : 1 Distribution of beneficiaries according to their level of participation

n = 60

n = 60

S. No.	Level of participation	GO		NGO	
		F	%	F	%
1.	Low	11	18.33	9	15.00
2.	Medium	42	70.00	10	16.67
3.	High	7	11.67	41	68.33
Total		60	100	60	100

Mean : 19.36

SD : 2.3

Mean : 25.11

SD : 3.6

NGO were having more extension contact, mass media exposure, scientific orientation and level of aspiration and it also reflects the good efforts made by the implementing officials and extension personnel of NGO's.

In case of GO the level of participation was medium. Hence the extension agency should motivate to increase participation by maintaining official contact with majority of beneficiaries, taking up proper follow-up activity, giving wide publicity to ongoing extension programmes, promoting co-operation among beneficiaries

through consensus, selection of real beneficiaries without any bias and political interference in the programme should be avoided normally.

From the findings it could be concluded that officials of implementing agency and extension personnel must take appropriate and concrete steps to bring the level of participation to higher echelons in GO as on par with NGO.

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